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PUBLIC WORKS

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Devoted to the interests of the engineers and technical officials of the cities, counties and states

VOL. 72. NO. 8

A. PRESCOTT FOLWELL, Editor

AUGUST CONTENTS

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STREETS AND HIGHWAYS:

Selling County Commissioners and the Taxpayers on Good Equipment. *By R. R. Ballou* 9
Airlane Flight Strips Along Highways 12
Unusual Operations in Surfacing, Using Tar. *By J. Carroll Boynton* 13

SEWERAGE AND SANITATION:

Modern Plant Solves Difficult Packing Plant Waste Problem. *By D. H. Hurst* 11
Baltimore Sells Sewage Effluent to Steel Plant 38
Sewerage Digest 41

WATER SUPPLY AND PURIFICATION:

Chlorination at or Near the Breakpoint. *By J. McClure Wardle* 14
Sanitation, Maintenance and Control of Watersheds. *By F. H. Whitley* .. 17
Applying Copper Sulphate to Reservoirs 38
Waterworks Digest 39

GENERAL:

Editorial 7
Lamp Makes Triangulation Survey at Night Possible 16
1940 Work in Bemidji, Minn. *By E. W. Downward* 16
Keeping Up With New Equipment 44
People—Here and There 47
Reader's Service Department 48
For the Engineer's Library 50

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WITH

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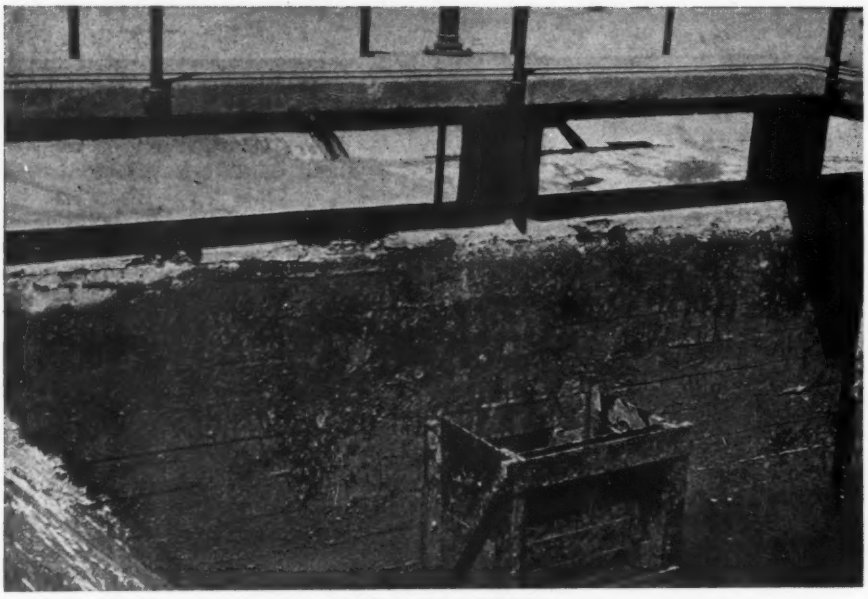
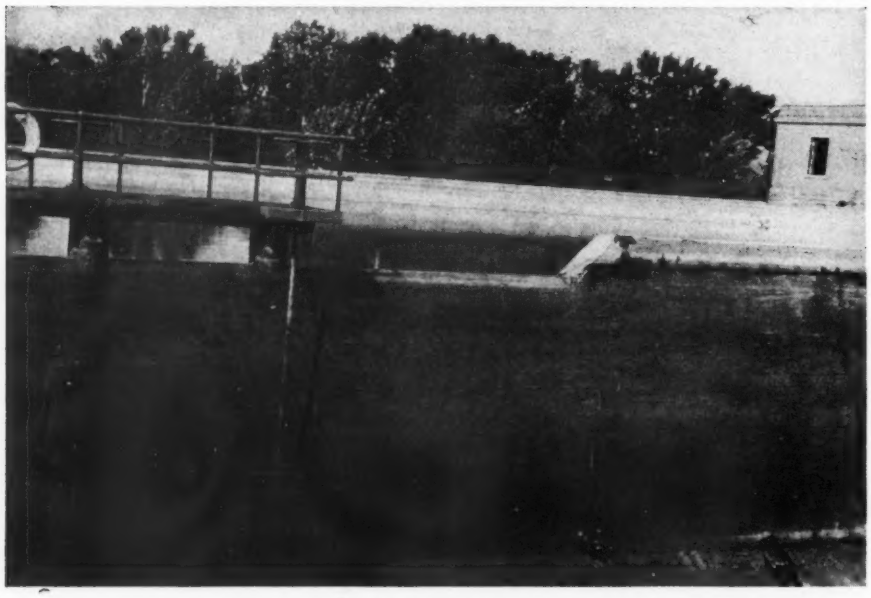


BEFORE THE BLACK OUT
This is a view of the weir wall when the basins were emptied for washing in May, 1939, despite applications of copper sulphate.



AFTER THE BLACK OUT
This is a view of the same weir as in picture above when the basins were emptied for washing in October, 1939. Note the effectiveness of the Black Out treatment as shown by the absence of algae.

The superior ability of AQUA NUCHAR Active Carbon to remain in suspension in water for a long period of time prevents penetration of sunlight to any great depth in the sedimentation basin. Since sunlight is one of the essentials for algae growth, this important characteristic of AQUA NUCHAR prohibits the propagation and growth of algae by "blacking out" light penetration.

See your March, 1941, issue of "Taste and Odor Control Journal" on "Blacking Out Algae." If you have not received your March, 1941, issue, write to our nearest office for one today.

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When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 48-49

The Editor's Page

To Our Readers in the Army

There is scarcely an engineering organization in the United States that has not lost some of its men to the Army. Whether they are in for one year or for the "duration" we will be glad to hear from them. As space permits, we shall be delighted to publish notes and news from them and about them. So far as we can, we shall be glad to answer questions about the Army. If the demand justifies it, we will institute a special section covering this subject. Subscribers who enter the Army service can have addresses changed, as necessary, by writing us, so as to continue to receive their copies of PUBLIC WORKS. Heads of departments are invited to send us personal notes about their employees who have joined the service telling where they are stationed and their rank.

The PWA Is in the Picture Again

The Public Works Administration is charged with the expenditure of $150,000,000 national defense funds for improving conditions in areas that, because of defense activities, require help. This work will be of all types, as illustrated by recent requests from the Norfolk, Va., area, which included: Norfolk, access roads, $642,000; additions to the water supply, $2,161,000; also schools and recreation facilities. Portsmouth, Va., sewers, $617,000; streets and highways, $930,000; storm drainage, $105,000; additions to water supply, $591,000; incinerator, $75,000; and sewage disposal, $2,000,000. Newport News, water supply, $1,140,000; sewage disposal, $1,788,820 (unless a general sanitation district is formed); bridges and street improvement, $1,000,000. Elizabeth City County asks $127,000 for sewers and $67,500 for an incinerator. Hampton, Va., asks $450,000 for sewage disposal and $40,000 for an incinerator. Williamsburg, Phoebus and other areas also put in requests for grants.

There has been an urgent need for some provision to assist local communities in defense areas to meet the demands imposed on them by rapidly increasing populations which offers the PWA an unusual opportunity. It is to be hoped that it will rise to the situation and carry on the work promptly, and with a sound engineering approach. PWA's last campaign was handled capably enough, but its predilections for the cheapest equipment and standardized (by many years of use) methods were not of the happiest.

Essentials in Subdrainage for Airports and Highways

The study of essential factors in subdrainage has been intensified during the past few years. Looking backward, it seems most strange that basic knowledge regarding so important an engineering matter has been so slow in development. Failures in highway surfacings which we now know are clearly due to improper subdrainage were ascribed to other causes or were accepted as being a necessary evil.

The newer knowledge of soils is an important aid in evaluating subsurface conditions and devising adequate drainage, but even without such knowledge, sound drainage structures can be installed that will give long-time satisfaction if a few basic essentials are observed. In general these include: Use of the best of materials; there is no place under a costly pavement for cheap substitutes. Looking and looking again, by means of test pits, at underground soil formations and water tables (especially in wet weather) in order to learn what the conditions are. Making subdrains amply deep, using the best of drain pipe and backfilling carefully with proper materials; late knowledge suggests much finer pervious backfill than previously used. Provision of a free outlet to remove the collected water.

All of these can be condensed into a few words—study your conditions, decide what should be done, and use materials that will do the job permanently. Remember that subdrains must continue to function automatically day and night and year after year.

The Army's Mosquito Control Program

Sanitary engineers, and many others, will be interested in the mosquito control campaign now being carried out by the Army as a part of its program for the protection of the health of the troops. The work is not restricted wholly to disease-carrying mosquitoes, but is intended also to cover pest mosquitoes where these materially affect comfort. The work is now under way in nearly 100 camps, cantonments and posts, from Alaska to Florida. The general direction and planning is being carried on by the office of the Surgeon General of the Army. Under camp and post commanders and surgeons, the detail work is being planned and performed by sanitary engineers assisted, in some cases, by entomologists. There are approximately 100 sanitary engineers, commissioned as officers in the Sanitary Corps in grades from 1st Lieutenant up, now engaged in this work. It is not, however, their sole job, as they are also responsible for the supervision of water supplies, sewerage, waste disposal and other similar work in the camps in which they are stationed.

Work against mosquitoes was started in April when $1,500,000 was made available. About two-thirds of this was spent in the first three months of the campaign and more has been granted since to continue the work.

Problems have varied greatly, and all kinds of tools have been used. Picks and shovels are useful, but they must be and have been supplemented by draglines, hydraulic scrapers and bulldozers. Dynamite is being used for trenching in some wet areas where other equipment cannot be employed efficiently. In order to maintain control, larvicides, oil and paris green also are utilized.

It Takes WATER TO WIN A WAR

FOR MEN, machines and materials there is no substitute for water. Every factory, city, air field, army camp or munition plant engaged in defense work should have an abundance of water—preferably from its own Well Water System. A water shortage or failure would play havoc with any production program.

In selecting a Well Water System you would first look to a firm that had a dependable reputation. It should have proven itself over a long period of time. Next, their product should be of unquestionable merit. All of these basic factors and many more are enjoyed by Layne—"The World's Largest Water Producers." The Nation-wide Layne organization has the men, equipment and skill to undertake and promptly complete any size water producing project anywhere in the United States or possessions.

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PUBLIC WORKS Magazine . . AUGUST, 1941

VOL. 72. NO. 8

Demonstrating modern equipment for the County Commissioners.

Selling County Commissioners and the Taxpayers on Good Equipment

Actual demonstration, rather than argument, with publicity of results and cost figures, convinced commissioners and taxpayers that replacing worn-out equipment with new modern types would lower costs as well as improve quality of work on roads.

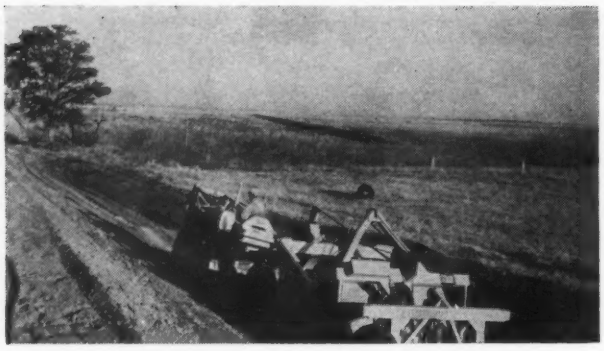
By R. R. BALLOU
County Engineer, Lincoln County, Kansas

WE IN Lincoln County, being one of a group of twenty-five County Unit Systems in a state of one hundred and five counties, feel that we are in the position of being watched as to expenditures and results. We are being watched by our neighboring counties, scrutinized and criticized by our state legislators, and are being made the object of a study on a nation-wide scale, state by state, by the Bureau of Public Roads.

A fact now universally recognized by Highway Officials is that there must be a uniform and unified connected system of highways penetrating all the rural communities; and this system must be based on improvement and development of the roads that will best serve these communities. Political interest and personal favoritism can have no place in the spending of the highway dollar.

In the writer's opinion, one reason for eliminating the township trustees from active road work was their reluctance to impose taxes for the improvements demanded by their citizens.

No one particularly delights in paying taxes; but if he pays them, he expects to get what he wants, and to get value received for the money put out. Too many of us are inclined to think in terms of the present only, as exemplified by all of our Federal Agencies organized on an emergency basis, rather than taking care



One of our tractors and scraper constructing a fill and making a channel change.

of the present needs and anticipating the demands of the future. People are determined to have good roads; and if one public official will not give it to them, his near-future successor will.

With the above facts as a background, the County Commissioners in 1936 understood (although they did not care to recognize the fact) that we had on our hands a large number of obsolete, constantly broken down items of road equipment. Here again, we face the fact that a successful unit system must own and maintain the equipment necessary to provide the highway service that modern times demand.

We owned, in 1936, eight 20 h.p. crawler tractors and pull patrols for maintenance work; three 60 h.p. crawlers and graders for the heavy grading; and one 42" elevating grader. We also had two 1½-ton trucks and one ¾-ton truck.

We found that in 1936 we had spent $5,931.93 for repairs alone, an average of $494.32 per month on the above mentioned units, not including the trucks.

This equipment, of course, was slow and heavy, and gasoline operated. The writer felt that we needed all new equipment—faster, more versatile, and diesel powered. Here, of course, I met with opposition. As a typical County Board, they felt that the expenditure sheet would look better if we spent $500 or $1,000 per month for repairs, rather than $5,000 in one sum for new equipment. Personally, I feel that local officials should welcome the opportunity of giving a strict accounting for the expenditure of the road taxes returned to them, rather than try to hide and divert their cost by calling for costly repairs.

No one will operate his automobile in private business or operate his tractor on the farm, when these machines have operating costs higher than their earned income. These same people certainly do not expect to have public officials handle their government business any other way.

Rather than trying to force the issue at this point, I adopted the policy of passive resistance. I did not try to convince them I was right (which I might not have been) or expect them to jump at conclusions, but waited my time to demonstrate actual conditions on our own jobs, as well as to show them contractors who were using these methods in order to make a profit. The first big obstacle, of course, was the diesel powered vs. the gasoline powered units. Our Caterpillar dealer offered to sell them a 60 h.p. tractor and to pay for this with the operating savings over the gasoline unit. We purchased our first Caterpillar RD7 in December, 1936. In March, 1937, we bought two more and the superiority of diesel power was established.

This transaction, of course, was publicized through the local papers, which I think are the best medium for keeping contact with your taxpayers. Always make friends with your local newspaperman, for he moulds a lot of your public opinion.

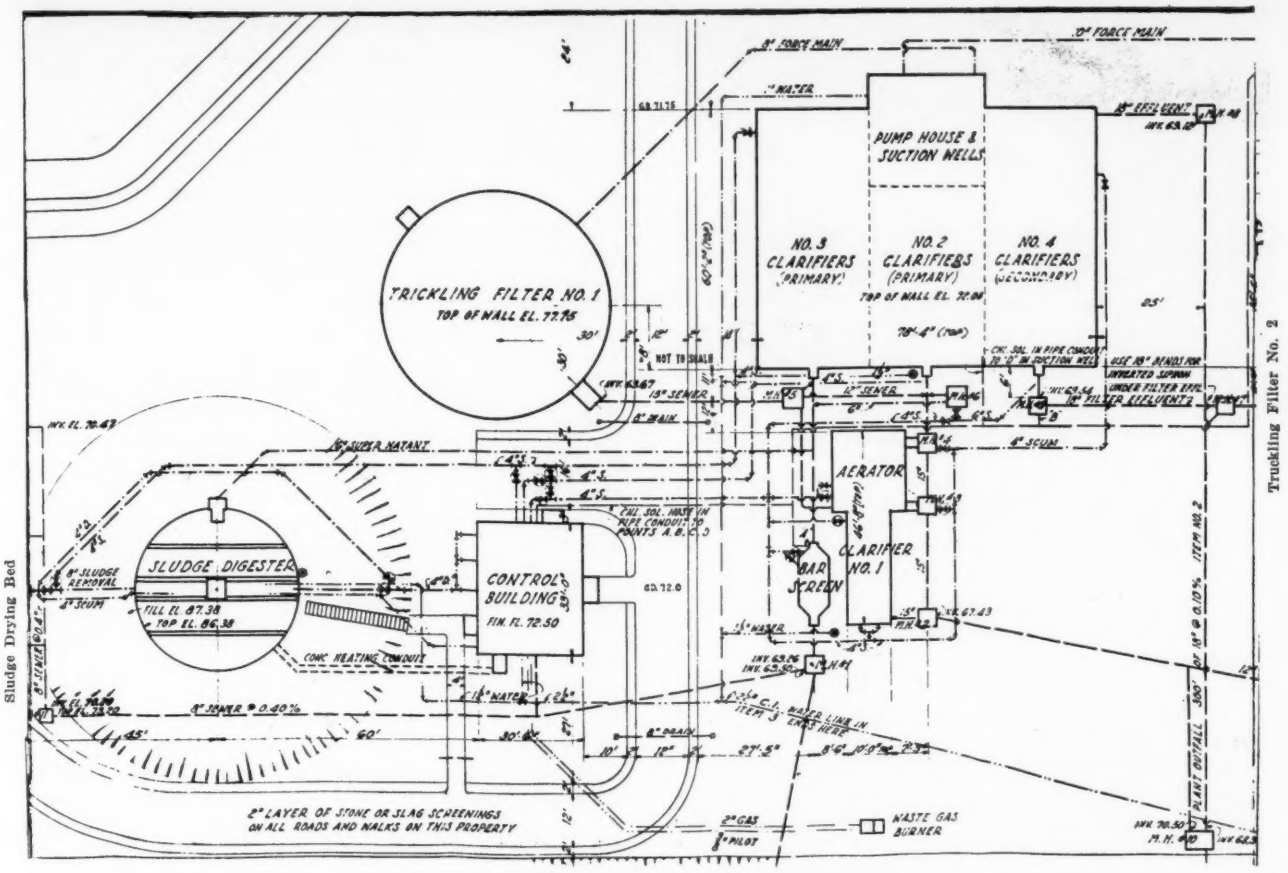
The work these three tractors were doing soon convinced the taxpayer; if he was interested enough to ask to see the cost record, he was further convinced and became one of our best salesmen for good roads in his community.

Next came the matter of surface maintenance. Here again, in order for the County Unit to operate successfully, the township line as a maintenance division must be effectively broken down; and the intermittent road dragger, together with his co-worker, part farm and part road time, must be relegated to the past.

I arranged for demonstrations that summer of several makes and types of road maintenance equipment, to be held in this county, at which several adjoining county road officials were present. As a result of this demonstration, we purchased in September, 1937, three tandem drive auto patrols, and another auto patrol and two tractors and wheel scrapers in January, 1938. In January, 1939, we purchased a larger auto patrol and in May, 1940, three more. This brought our total equipment purchased as of January, 1941, to an investment of $75,452.18. This amount does not include three 3-ton trucks and one 5-ton truck purchased during that period.

Since the purchase of our Diesel powered tractor in 1936, we have co-operated with the W.P.A. wherever possible and have had good equipment available at all times. With help of W.P.A. and this equipment, we have built about 425 stone masonry bridges and culverts, constructed fifteen miles of native clay-gravel surfaced roads, applied 24,600 cubic yards of crushed rock to 41 miles of road; widened, elevated and put to standard grade about 100 miles of road in a county that is very rough, and is made up principally of limestone, which is pretty tough going all the way through. Such topography calls for large drainage structures, deep cuts through the hills, and large fills. Such work is also tough on machinery and men. We are now maintaining all of our 1,180 miles of road full width; and by operating twenty-four hours a day, we are able to have a smooth surface within a few days following every rain. Also, being equipped with snow plows, are able to get every resident to town within three days following a snow. The public has come to expect these things and are demanding more every day; and they tell me, if it takes more or better equipment, we better get it, because they will pay for it, whether they own the equipment or not.

One of our No. 12 autopatrols preparing to relocate a road prior to construction of the bridges.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Sludge Drying Bed
Trickling Filter No. 2

Layout of the Tifton, Georgia, sewage treatment plant.

Modern Plant Solves Difficult Packing Plant Waste Problem

Packing plant waste, which constitutes half the sewage of Tifton, Ga., is treated in special clarifiers and a special trickling filter before being mixed with the sewage, and the mixture is then clarified and filtered.

By D. H. HURST
City Engineer, Tifton, Ga.

COMPLETION of an up-to-date sewage plant in the early part of 1940 caused the city officials of Tifton, Ga., to breathe a sigh of relief over the solution of a problem of long standing. The plant was built to treat sanitary sewage and Armour Packing Co. waste. At the time the plant was constructed the city had a septic tank in which the sewage was settled. Following this preliminary treatment it was discharged into a branch about a mile beyond the city limits. The packing house waste also was dumped into this branch, which is only a wet weather branch; and during dry weather the sewage and packing waste was the only flow the branch had.

At that time the city and county were spending $2,000 annually for mosquito control. Since the plant was put into operation January 1, 1940, this cost has been entirely eliminated.

Design capacity of the plant was fixed at 1.25 mgd, this being double the present flow of .625 mgd, of which .325 mgd is sanitary sewage and .300 mgd is from the Armour packing plant.

The plant consists of one coarse bar screen; two clarifiers for the city for primary settling; one clarifier for the Armour primary settling; one aerator; two clarifiers for the Armour primary effluent after aeration; two final clarifiers for the combined flow; one primary trickling filter, 55 ft. in diameter for the Armour packing waste; one trickling filter, 115 ft. in diameter for the combined flow. A brick pump house contains a switchboard and automatic controls for sewage pumps and wet wells, in addition to five sewage pumps in the basement. There are two Venturi meters. There is also a control building, a brick structure containing a chlorinator room, a storage room,

View of part of Tifton plant, from top of digester. Control building at right. Pump house at left center. Trickling filter No. 2 in background.

a room for three sludge pumps, a sewage gas fired boiler, a flow indicator and recorder, an indicator for hot water supply and return from digester, switchboards for all outdoor motors, laboratory, and toilet. There is one digester and three drying beds for sludge drying. The plant is of the latest design and employs recirculation.

The sanitary sewage from the city is delivered to the plant through a 15-inch sewer, flowing through the coarse bar screen as it reaches the plant. The Armour Packing waste is delivered through a 12-inch sewer into the Armour primary No. 1 clarifier; from there to the aerator (which was furnished by the American Well Works), from which it flows by gravity to the two Armour primary clarifiers and through a Venturi meter to the wet wells. From here it is pumped to the 55-ft. trickling filter with sewage pumps which were furnished by the Yeomans Brothers Co. From the filter the flow is combined with the city sanitary sewage, in a manhole where, if desired, the flow from the filter can be split and sent back through the aerator.

The combined flow then passes through the city primary clarifier No. 3, and then through a Venturi meter which measures the combined flow to the wet wells. The combined flow is then pumped to the 115-ft. trickling filter, which is equipped with American Well Works sewage distributor. From the filter the effluent flows to the final clarifiers, which are equipped with the Jeffrey Mfg. Co. sludge collectors. The sludge is pumped to the digester with plunger type sludge pumps furnished by Ralph B. Carter. The final effluent is discharged through a 15-inch sewer to the branch.

The digester is heated with a Crane boiler built by the Bastian Morley Co. and is fired by the sewage gas, which is collected in a water-sealed gas dome in the top of the digester. The average output of sewage gas is 7,000 cubic feet per day. The gas is measured by a gas meter furnished by the American Meter Co. From the meter the gas then passes through a P.F.T. flame trap to a boiler and a waste gas burner.

The plant was designed by Wiedeman & Singleton, Consulting Engineers, Atlanta, Ga. It was built as a WPA project, with a 45% grant from the Government, by Smith & Pew Construction Co. of Atlanta, Ga., at a cost of about $96,000.

Average operating cost per month is $250, which includes labor, electricity and maintenance.

Laboratory data for 1940, when the average flow was .625 mgd, is as follows:

	Suspended Solids	*Dissolved Solids*	*5-day BOD*
Influent, city sanitary sewage	362 PPM	642 PPM	260 PPM
Influent, Armour waste	554 PPM	3000 PPM	1000 PPM
Plant effluent	30 PPM	1500 PPM	22 PPM
Relative Stability—10 days.			

Airplane Flight Strips Along Highways

Airplane "flight strips" for which appropriations of $10,000,000 in Federal funds are authorized in the Defense Highway Act passed by Congress July 24,* constitute auxiliary landing areas for the use of military aircraft. It is planned to build these adjacent to public highways sufficiently straight to permit construction and where rights-of-way of adequate width are available.

Specifications now under consideration by the War Department include an area for each flight strip of not less than 300 feet in width and 3,000 feet in length. The area may be as much as 800 feet, by 8,000 feet where terrain will permit. Size will depend upon the type of military airplane using the area.

The term runway should not be incorrectly used for a "flight strip" since a landing area for aircraft is more than actual ground space required for runway, apron and other facilities, if any. Runways for military use will have a minimum width of 150 feet, minimum length of 3,000 feet for the use of pursuit ships and 4,000 feet long for the use of all other military aircraft. These specifications are at sea level and subject to corrections for elevations.

Approach areas will be free from encroachment by high buildings or other obstructions, and will allow clearance for safe approach to flight strips.

Ground not used by planes in take-off and landing may be uneven, but the runway itself will be smooth with not over a one per cent grade for the entire area of use. Surface for the runway, whether paved or sod, will require adequate bearing characteristics. Treatment of the soil may be some form of stabilization, such as the use of heavy grass turf.

Flight strips will be located within 5 to 50 miles of Army air bases. Runways will be constructed for probable loadings of 40 tons to one wheel and a gross weight of 80 tons. Speeds allowed for will be 25 to 90 miles per hour air speed for landing, and 35 to 100 miles per hour ground speed for take-off.

Runways will be constructed in the direction of prevailing winds. Permanent buildings will not be allowed on flight strip areas. Boundary lights but no flood lights are planned for flight strips.

In the location and development of flight strip areas, the several State highway departments, the Public Roads Administration and the Air Force commanders will cooperate, and the regional managers of the Civil Aeronautics Administration will be consulted about the general location in relation to other landing facilities.

After preliminary agreements have been reached with the proper Federal and State authorities, appropriate maps with the sites indicated thereon will be forwarded to the War Department, through the Commissioner of Public Roads, for examination and concurrence by the Chief of the Air Force. Subsequently, favorable War Department action on the data submitted will constitute approval of these works as national defense projects.

The War Department intends that the flight strip program will augment and supplement rather than interfere with or detract from the present national airport program. No drastic changes are anticipated in highway improvement planning except that in some cases highways will be placed on one side of wide rights-of-way instead of in the center, thereby allowing space for flight strips.

*Vetoed Aug. 4, but this item probably will pass ultimately.

Method of dragging broom.

Arrangement of brushes on broom.

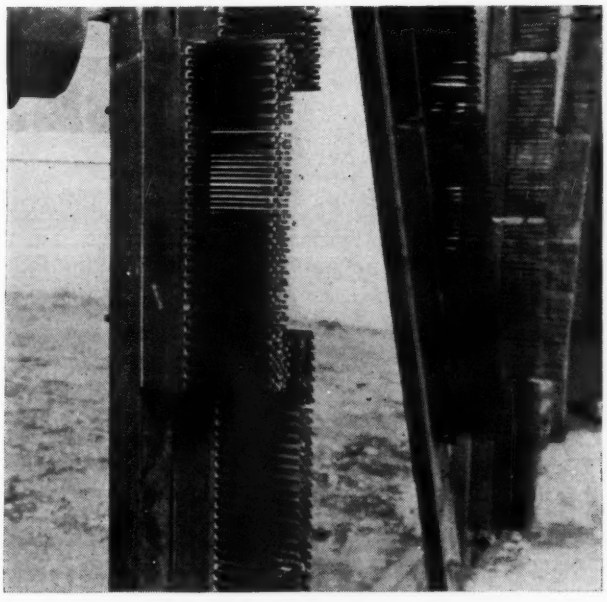
Unusual Operations in Surfacing, Using Tar

By J. CARROLL BOYNTON
Highway Surveyor, Whitman, Massachusetts

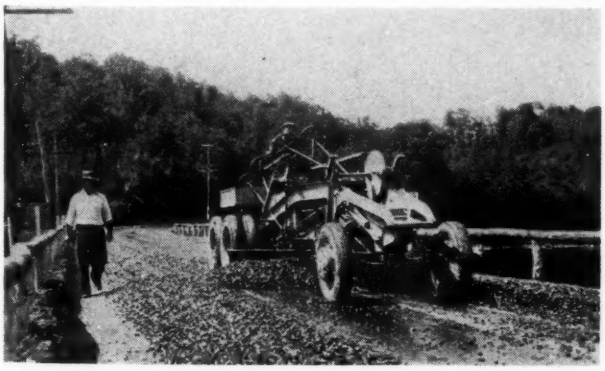
WE HAD to deal last season with several much-traveled roads in which pot holes were forming to such an extent that the necessary patching made the surfaces quite rough; also the cost of maintenance was appreciable and rising steadily. Our appropriation being too small to provide for new construction, and even too small to permit placing a covering of hot mix, we were forced to seek another solution.

On the first of these roads we applied 0.5 gal. per square yard of T-6 tar, then spread 40 lbs. per square yard of 5/8-inch stone over this. Next we weighted a regular drag broom with 600 lbs. of ballast. 150 lbs. in each corner. This drag broom consisted of a frame 6 ft. x 12 ft., equipped with Kinney steel brushes, the wires being four inches long. This broom was dragged over the stone until it and the tar were thoroughly mixed. Then the weights were taken off and the broom was dragged light. This second application of the broom smoothed the surface of the road-way, while the first brooming mixed the tar and stone. We then applied one-tenth of a gallon more, covered it lightly with sand and let the traffic roll it down. It has been in service about a year now and shows no signs of wear.

Another operation that proved economical as well as interesting was the correction of a gravel base that had been penetrated with grade T-3 tar during a heavy rain shower. We first took over this section of road about eight months after construction. Hardly a week went by that we didn't have to patch some part of it, especially after a rain. The cost of patching was fast becoming a burden. This condition we considered due to the stopping of the penetration of the tar by water which had filled the gravel before it was applied.



Type of brush used on broom.



Resurfacing with tar and stone mixed in place.

We corrected this condition in about the same way as the road first mentioned, but we used 50 lbs. of clean sharp sand per square yard instead of 5/8-inch stone, and one-half gallon of T-4 per square yard. The results were more than satisfying. It produced a smooth, even surface of about one-half inch average thickness. This section is still as good as the day it was done, though it should be sealed with a quarter of a gallon of T-9 tar and 25 lbs. of sand per sq. yard.

This year we are contemplating resurfacing some of our roads with tar and stone, mixed in place. This type has been gaining favor rapidly in our section

(Continued on page 38)

J. McClure Wardle

Chlorination at or Near

Adoption of breakpoint chlorination eliminated gas formers, reduced color and turbidity and eliminated manganese, with some reduction in chlorine taste and odor.

I SUPPOSE there are various reasons why a water system goes to breakpoint chlorination. In the case of Hudson, a glance at Figs. 1 and 2 best tells the story. With pre-treatment, filtration, and post-treatment giving results no better than the final water showed during the summer months of 1940, one was inclined to lose faith in the potency of chlorine as a disinfectant—that is, with residuals as we have heretofore used them. With the highest practicable doses and conventional residuals giving such results, some explanation was necessary and this led, I believe, to the birth of that much used term "Chlorine resistant" bacteria, which nicely mastered almost any situation and certainly was a comfort to any operator who was trying to keep his salary and residual up where they belonged.

First a brief description of the Hudson water system is in order to acquaint the reader with the type of water and method of handling. It is a surface water supply with a catchment area of about 25 square miles composed chiefly of farmland and some vacation areas. The creek water reaches an 85-million gallon storage reservoir which provides a theoretical detention period of some 40 days. From here it is pre-treated with chlorine and ammonia to give between 0.3 ppm. and 0.5 ppm. residual, and flows three hours to an open slow sand filter located in the city. The filter effluent usually shows a residual of 0.1 ppm., although we would much prefer a trace. However, the prime consideration in the pretreatment was to extend the filter runs from 6 weeks to 6 months, to permit filtering throughout the winter. Post-treatment follows filtration immediately because of the physical layout, and the final water then flows to the two open clear-water distributing basins holding about two days' supply and located adjacent to the filter. The conventional grid iron distribution system begins within a quarter of a mile from these basins and extends over an area of approximately two square miles.

Now back to the curves (which we can't seem to do without). Fig. 1.—not a bad year up to the first of June; middle of June, pretreated water not so good, but the old filter and post treatment seem to be holding. With the graph in plain sight I cannot create suspense so let's jump right into the thing and try to decide just how effective filtration and post treatment would have been had not the quality of the pretreated water improved toward the end of July, more or less naturally. Your guess is as good as mine, but there were some anxious moments last summer as you will observe when looking at Fig. 3 to see the post-treatment chlorine being stepped up from April on. Note the residuals going up to almost 0.6 ppm. and in August, near the middle of the month, there is the final water worse than the pre-treated. (Fig. 1.) "Chlorine resistant" bacteria? I wonder!

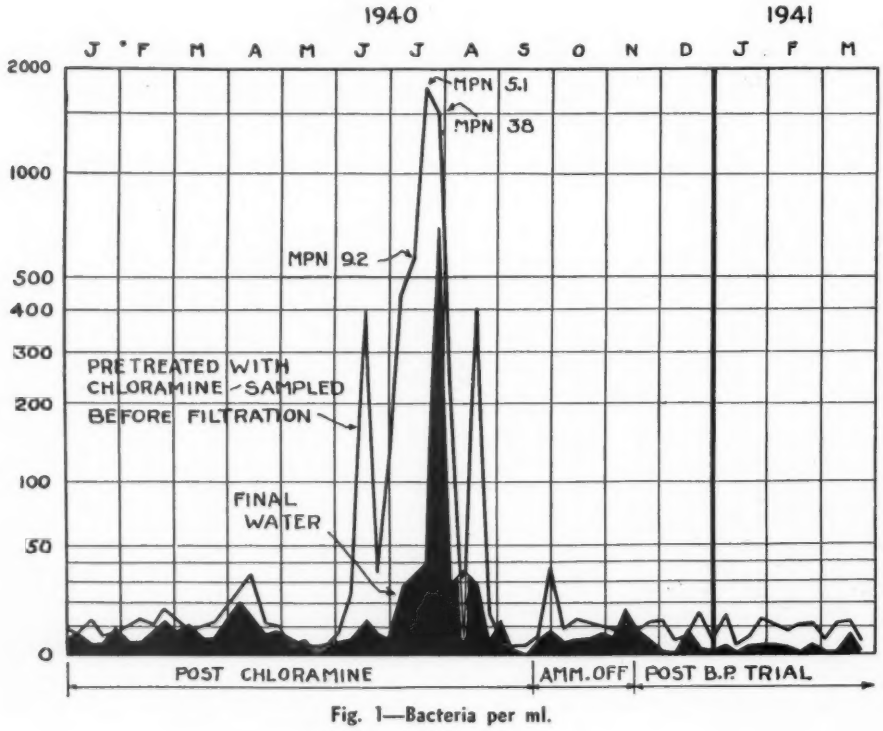


Fig. 1—Bacteria per ml.

About this time (September) we began to think of super or breakpoint chlorination and ran a high chloramine residual while we pondered and tried to analyze the situation. Of course, as you will have noticed, the pretreated water settled down in fright, giving us time to make a few short breakpoint tests on a plant scale, clean our filter, and get set to give breakpoint a trial.

Let's go back a bit to review our analysis. We noticed from April on, with increas-

the Breakpoint

By J. McCLURE WARDLE
Supt. Public Works, Hudson, N. Y.

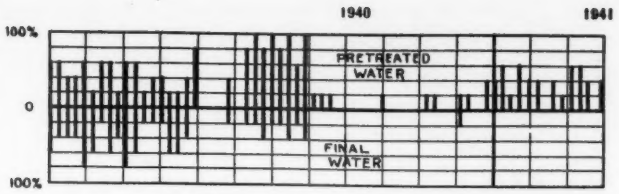
ing residuals (chloramine) Fig. 3, that we were cutting down the percentage of 48-hour gas formers (Fig. 2) until, around August 1st, with about 0.6 ppm. residual, we were free of them in the final water for the first time in many months. We also found a reduction in color (Fig. 4) which had been higher in the final water than in raw. During most of September we carried a 0.75 ppm. residual and, while nothing was proved bacterially because of the exceptionally good quality of the pretreated water, the color took a decided drop, as did the turbidity (Fig. 5) and the manganese (Fig. 6).

You can well imagine it was not a good tasting water at these residuals and at this point it was decided that some form of super-chlorination looked worth a try if we did not have to suffer with objectionable tastes and odors. Of course we thought of breakpoint. However, the decision to try it was made with fingers crossed because, for various reasons, dechlorination or taste removal could not be considered.

Beginning the middle of November, post-treatment breakpoint was started at about 2¼ ppm. giving 0.15 ppm. residual after a 3-hour contact period. Within a few days the physical quality of the water improved greatly. I noticed a slight chlorine taste rather "clean" in character but let it ride for an end result with the public. No complaints were received. On the other hand no compliments on the improved quality of the water were forthcoming so I must conclude that our consumers are more or less indifferent to small changes in the character of the water. Personally I think the water has tasted better than is usual throughout the winter months when even the lowest residuals always gave some taste and odor troubles.

From this point on, Fig. 3 shows how we monkeyed around the breakpoint in an endeavor to find the optimum operating point. Invariably when we went below what we considered the breakpoint we had the typical heavy chlorine odor, but seldom any taste; when we operated above the breakpoint there was seldom an odor but most always the light chlorine taste. All efforts to consistently split this difference and have no taste or odor have been unsuccessful to date, and while theoretically it seems there must be a change-over point, expert advice that I have sought seems to indicate that it is probably there but very critical.

All told, the chlorine taste and odor is no worse than before and, I believe, considerably less, so we might consider we have gained in the elimination of gas formers, the reduction in color and turbidity, and so far in the complete elimination of manganese. The manganese has never reached the U. S. Treasury maximum of 0.3 ppm. even with the normal amount of iron



PERCENTAGE OF SAMPLES SHOWING GAS IN 48 HRS.
FIG. 2

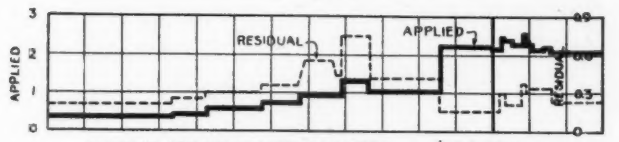


FIG. 3

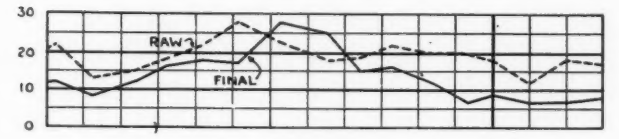


FIG. 4

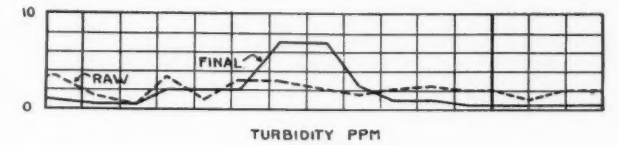


FIG. 5

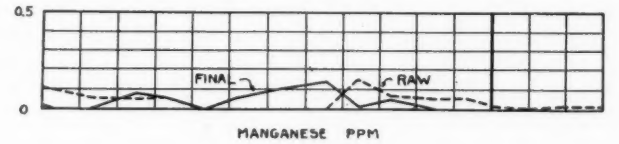


FIG. 6

Results during 1940 and January-March 1941

in our water added, and therefore has not been a major problem with us. However, it seems worth while to pass this observation along to some reader who might have such trouble and wish to experiment a bit. From Figs. 4, 5 and 6 it can be seen that its incidence coincides with the high color and turbidity. As a matter of fact the appearance of the final water in the clear water basins at this time was very murky and of a greenish caste making one think of algae growths. However, repeated microscopical examinations failed to show the presence of any algae whatsoever and two doses of copper sulfate at 4 lbs. per M.G., put in a week apart, had no effect except to change the green color to the brown side. As stated before, the higher chlorine dose beginning in August (Fig. 3) corrected the situation so that the improved condition was clearly shown in the September chemical analyses.

I believe everyone interested is always intrigued by examining breakpoint curves, particularly those that do not run to 20 or 30 ppm. of applied chlorine, so I have included the one of our final treatment (Fig. 7). This is made from averages of several runs with 2-hour and 3-hour contact periods. It closely follows the laboratory tests and is probably a good representation. Under varying conditions as to contact and reading time and pre-ammonia doses, we have seen the hump rise to 1.0 ppm. residual and the dip go down below 0.1 ppm. but always these occurred at about the same points on the curve, namely 1.2 ppm. and 2.25 ppm. of applied chlorine.

Because all curves cannot here be included, there follows a listing of other properties of the water to-

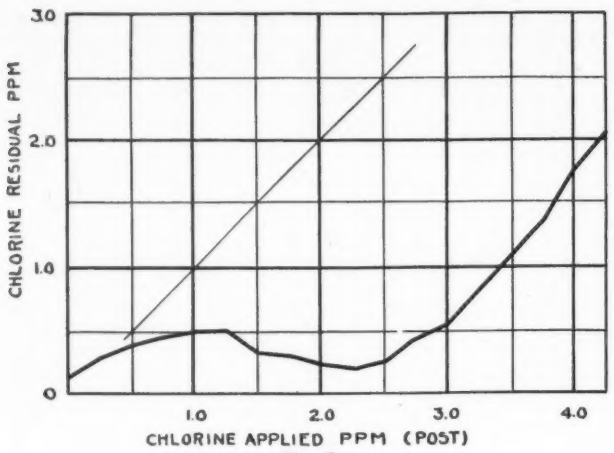


Fig. 7

gether with notations as to changes attributable to breakpoint chlorination.

Temperature—34 degrees F. winter to 80 degrees end of July.

Hardness—30 to 50 ppm. No noticeable change.

pH—6.5 to 7.3. No noticeable change.

Free CO_2—3 to 7 ppm. No noticeable change.

Alkalinity—18 to 38 ppm. No noticeable change.

Iron—0.05 to 0.20 ppm. No noticeable change.

Chlorides of course increased from about 5 ppm. to 8 ppm. and it may be noted that this increase did not occur during the high residuals below the breakpoint when color, turbidity and manganese were lowered, but only after the breakpoint treatment had been started.

The charts have been included not only to clarify the text of this article but to permit the reader to draw some conclusions of his own. Several persons whose opinions I greatly respect, upon examining the full set of curves, have immediately noted interesting points that I had failed to detect. So it is with this thought in mind that these observations and data are passed along, and not with the idea of rushing into print with hasty conclusions.

In conclusion, it seems that we have gained by using breakpoint chlorination. Our chief aim of course is the effective kill of "Chlorine Resistant" bacteria and those desperate months of June, July and August, which are almost here will show us up—right or wrong. Better the Editor had waited 'til October for this article but maybe there would be no article. In the meantime we are putting up a bold chlorine front to meet the test.

As a final check I just took a drink of water and I don't cheat at solitaire, and I don't taste or smell any chlorine—today.

Lamp Makes Triangulation Survey at Night Possible

A tiny but highly concentrated beam from a very efficient electric signal lamp enables the United States Coast and Geodetic Survey to do much of its highly important triangulation survey work at night, when conditions are most favorable for accurate results, according to the Department of Commerce.

The signal lamp, developed by the Survey, is operated from dry-cell batteries and has a concentrated filament accurately placed at the focus of a parabolic reflector. A lightkeeper at each station on which observations are being made directs the beam toward the observer's station. When necessary he can communicate with the observer by obstructing the light beam and making a series of dots and dashes in the Morse telegraphic code.

These signal lamps have the additional advantage that they can be seen in cloudy weather, provided the clouds are not in direct line of vision. If all the lights to be observed are visible when needed the observations at a station may be completed during a single evening on all contiguous main-scheme stations.

Many interesting details concerning the nation-wide triangulation surveys made by the Coast and Geodetic Survey over a long period of years, together with an explanation of certain more recent developments will be found in Special Publication No. 227—"Horizontal Control Data"—just released. Copies of the publication may be had from the Superintendent of Documents, Washington, D. C., at 10 cents a copy.

1940 Work in Bemidji, Minn.

By E. W. DOWNWARD
City Engineer

The following construction work was completed under the Engineering Department of the City of Bemidji during the calendar year of 1940.

Asphalt Street Paving.—There were placed 22,363 sq. yds. of black top, or 11.5 blocks of new work and 2 blocks of seal work; also 600 cu. yds. of asphalt stock pile was placed for street maintenance, equivalent to 10,800 sq. yds.

Water Works Construction.—This includes: 3302.4 lin. ft. of 6-inch water main under streets; 133.0 lin. ft. of 6-inch water main connecting new pumps to street mains; 96.0 lin. ft. of 2-inch water main; 8 hydrants installed along the above water mains; 7 6-inch gate valves; the construction of 2 new pump houses; water tank and steel work painted; new frost casing erected; Nymore pump house remodeled; and drains installed under 4 pump houses. All 5 City pump houses now have an A-1 rating by the Minnesota Board of Health.

Sanitary Sewer System.—Construction included: 1257 lin. ft. of 21-inch sanitary sewer; 2411 lin. ft. of 12-inch sanitary sewer; 3346 lin. ft. of 8-inch sanitary sewer; a by-pass at Grit Chamber; rebuilding of the Comminutor; and the construction of 16 manholes, from 6 ft. to 22 ft. deep; 10 manholes were repaired.

Storm Sewer System.—This work involved: 587 lin. ft. of 10-inch storm sewer, 5 catch basins, 2 manholes, and 14 dry wells, 10 and 12 ft. deep. Also culvert and gutter construction.

Street Work.—With WPA assistance, the following work was completed: 28,849 cu. yds. excavation and fill; 1004 lin. ft. ditching; rebuilding of 3 bridges; various miscellaneous work; 12,872 sq. yds. sloping of banks; 195 sq. yds. Riprapping; 5777 sq. yds. asphalt laid down in street regrading; and 1350 cu. yds. clay spread on streets for stabilization.

Curb, Gutter and Sidewalk.—During 1940, there were built: 9074 sq. ft. of sidewalk; 4055 sq. ft. drive way slabs; 5289 lin. ft. curb and gutter; and 1230 lin. ft. straight curb.

Sewage Disposal Plant improvements included 5848 sq. ft. scraping old paint, primary and secondary tank, rooms and office; 5848 sq. ft. painting 3 coats, total 17,544 sq. ft.; 1257 sq. ft. roof remodeling with asphalt; 200 sq. ft. repairing brick walls; and 120 sq. ft. Riprap at Grit Chamber.

Miscellaneous work included 84 new sewer connections and 39 new water connections.

Rock Creek watershed of the Corvallis, Oregon, water supply.

The Sanitation, Maintenance and Control of Watersheds

Sources of pollution and methods of eliminating or counteracting them. Recreational use of reservoirs. Sanitary facilities for occupants of water sheds. Policing and patroling. Reforestation. Mosquito control.

By F. H. WHITLEY

INCREASING use of the automobile for recreational purposes and possibly an increased amount of leisure time have resulted in increasing demands for public recreational facilities on watersheds of public water supplies. In view of this increased use it is well to survey anew the subject of watershed control and operation, watershed sanitation, and the various practices which represent the present opinion of waterworks men. Inaccessibility as a protection to impounding reservoirs is seldom to be depended upon; sound regulations and procedures are needed also.

Since such a large number of municipalities use surface waters, it is obvious that the subject of watershed sanitation and the protection of the quality of natural surface water is one that is pertinent to many communities and water companies. Several large cities, including New York and Boston, use impounding reservoirs located in the mountains, with chlorination for the purpose of disinfection as the only method of treatment other than storage; but they are able to do this only by enforcing a very strict program of watershed sanitation. Even in the cases where there are complete treatment plants with coagulation and filtration there is usually need for certain measures of sanitary control to reduce the amount of pollution which the treatment process will be called upon to remove. This is necessary because of the limitations of water purification processes in removing pollutional substances.

The ideal source of a public water supply from the standpoint of sanitation is an isolated, forested watershed with no permanent habitation, and with all recreational uses for hiking, hunting, picnicking, etc., which would involve the temporary presence of persons on the watershed, prohibited. The attempt to maintain this type of watershed has resulted in the setting aside of large areas of land located comparatively near centers of population, the land being used for water supply purposes only. This has proved unpopular in many cases where the facilities for outdoor recreation are limited.

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The Objectives of Watershed Sanitation

The chief objective of watershed sanitation is to maintain a catchment area with as little pollution as possible to minimize the amount and cost of the treatment required to turn out a finished water that is free of pathogenic or disease-causing organisms and is acceptable esthetically. In order to produce an acceptable water, sources of bacterial pollution and substances which impair the appearance of water must be controlled to reduce the harmful effect on the water supply.

Watershed sanitation and control for unfiltered supplies require that attention be given to the following items:

1. Amount of cultivation of the watershed.
2. Population per square mile of watershed area.
3. Methods of sewage disposal, whether by treatment, or by diversion from the watershed.
4. Character and efficiency of sewage treatment works on the watershed.
5. Proximity of sources of fecal pollution to the intake of the water supply.
6. Location and character of industrial wastes.
7. Probable minimum time required for flow from sources of pollution to reach the reservoir.
8. Probable minimum storage period in reservoir.
9. Policies with respect to fishing, boating, swimming, picnicking and other recreational activities.
10. Efficiency and extent of policing.

The standards set up in 1925 by the Secretary of the Treasury for "Standards of Purity for Drinking Water Supplied to the Public by Common Carriers in Interstate Commerce," which have been almost universally adopted as the basic minimum standards of quality, state the following regarding surface water supplies:

"As to Source and Protection.

1. The water supply shall be—

a. Obtained from a source free from pollution; or

b. Obtained from a source adequately protected by natural agencies from the effects of pollution; or

c. Adequately protected by artificial treatment."

The decision as to whether a water supply source is actually free from pollution, or whether the supply is adequately protected by natural agencies from the effects of pollution must be determined by a sanitary survey interpreted in the light of bacteriological analyses.

The results of the bacteriological analyses are important in determining the success of watershed protective control measures. The common measure of the bacterial quality which indicates the degree of pollution is the determination of the density of the coliform group of bacteria. The coliform index, or the average number of coliform organisms per 100 cc. of water sample is obtained by suitable bacterial analyses. The coliform group of bacteria includes (1) aerobic or facultative anaerobic (2) Gram-negative (3) non-spore-forming organisms which (4) ferment lactose (5) with gas formation. It includes *Escherichia coli,* the intestinal group of bacteria, *Aerobacter aerogenes,* a non-fecal group of bacteria, and the *Citrobacter* family of bacteria. While the coliform index includes organisms which do not originate in animal intestines, it is generally the practice to determine probable numbers of organisms that fall into this classification as defined above, without going through the more extensive tests required to separate the several families of bacteria in the coliform group. Methods of analysis are given in *Standard Methods of Water Analysis,* published by the American Public Health Association.

The limits of coliform organisms in a water that has been treated and is considered safe for use as a drinking water have been generally accepted as an average coliform index of 1.0, or in other words, over a long period of time the average number of coliform organisms would be 1.0 per 100 cc. of sample tested. Data have been collected from many water supplies to show the bacterial quality of the raw water and of the treated and chlorinated water. Extensive studies by the U. S. Public Health Service show that where chlorination is the only method of treatment given a water, the coliform index density in the raw water should not be greater than 50 organisms per 100 cc. of raw water. If the treatment of water is by coagulation, filtration and chlorination, the maximum numbers of coliform organisms in the raw water that can be safely handled by the process is around 5,000 per 100 cc. of sample according to the U. S. Public Health Service.

Pollution and Contamination

There is frequently a confusion as to the meaning of the term *pollution* and another term frequently used along with it, *contamination.* The definition of these terms as generally accepted follows: *Pollution* of a water supply refers to the introduction into a water of substances of such character and in such quantity that they tend to render the body of water or river objectionable in appearance, or to cause it to give off objectionable odors. *Contamination* is the introduction into a water of bacteria or other substances which tend to render it unsuited for domestic use.

Sources of Pollution

All surface waters must be considered subject to contamination by polluting substances, even the very small streams draining uninhabited watersheds. Pollution of such water supplies can result from the careless use of the watershed by campers and other persons visiting the watershed. Frequently rainstorms will wash polluting substances into streams, resulting in the temporary presence of large numbers of bacteria. In the case of the larger streams and drainage areas, there is more possibility of human habitation and use of the watershed, with greater opportunity for pollution to occur.

Pollution of a surface water supply also may come from other sources. Untreated sewage from municipal sewers, homes, camps and hotels is a source of dangerous pollution. Neglected and carelessly located toilets or privies, and leaking cesspools are frequent offenders. Acts of pollution by hunters, campers and other visitors on a watershed are potential dangers. Garbage, dead animals and other animal or vegetable matter impair the attractiveness of water. In addition, there are various industrial wastes which may be very detrimental to the quality of the water into which they are discharged. These include waste brines from oil wells, acid mine drainage, dairy wastes, cannery wastes, and many others. Drainage from swamps and certain forested areas my add color to the water.

Natural Agencies of Purification

Fortunately for the water works man there is a natural process of self-purification which aids in taking care of these various polluting agents. However, the existence and action of a natural process of self-purification should not be interpreted to mean that flowing water will purify itself in a given length of stream. The degree of purification which results from

natural processes depends upon the length of time that the stream or lake contains the water without further pollution occurring. This time is not constant, but varies with the degree of pollution, the temperature, the amount of re-aeration of the surface water and the amount of sedimentation that takes place. The effect of self-purification is a reduction in bacterial numbers and in the amount of organic and suspended matter in the water.

In order better to understand the limitations of natural agencies in aiding watershed sanitation through the medium of self-purification, one should consider the progressive changes in the character of a stream receiving a polluting substance such as sewage. This purification process is present in any natural body of water which receives organic pollution, varying in extent and duration with the amount of dilution available, the velocity of the stream, the atmospheric temperature, and to a large extent upon the nature of the substance causing pollution.

The various phases in the chain of self-purification can be observed in a stream as separate zones along the stream, generally designated as:

1. Clean water
2. Zone of recent pollution or degradation
3. Zone of active decomposition
4. Zone of recovery
5. Clean water

Each of these zones has a typical appearance which serves as a useful guide to the degree of pollution.

The zone of clean water is usually characterized by freedom from turbidity, by the absence of brownish-black deposits on the stream bed, and by the presence of some green water plants in protected areas. There is usually an abundance of dissolved oxygen, usually over 75 per cent of saturation, and fish of all types will be able to live in the water.

The appearance of the zone of recent pollution will vary according to the degree of pollution, but in general the water will show an increase in turbidity with a grayish color, and there will be a disappearance of green plants. There is a reduction in dissolved oxygen and an increase in carbon dioxide, given off by various microscopic organisms in breaking down the organic matter which is causing the pollution. The numbers of bacteria and protozoa are usually high. Solids carried in suspension in the sewage, which cause the grayish color, usually settle out and if there is heavy pollution will form a blanket of sludge on the stream bottom. If this sludge blanket is present, the stream will be passing through that stage of self-purification called the zone of active decomposition. This sludge blanket will be undergoing decomposition and usually will contain small red worms. Where the sludge blanket is thick, there may be gas bubbles rising to the surface carrying offensive odors with them.

As the stream flows on past the zone of recent pollution and the zone of active decomposition (if there is one) the polluting substances will have settled out, or will be removed by the bacteria and protozoa which use such substances as food. Green plants will be present in the stream again. The color of the water will be clearer. This section of the stream is called the zone of recovery, and will be followed by a zone of clean water similar to that above the point of pollution. The numbers of bacteria will usually be much lower than in the polluted sections of the stream since most of them die when the food supply runs out.

All of these conditions may be present in a stream in the order shown after sewage has been discharged into the stream. The distance below the sewer outlet to a point where the pollution disappears is not always

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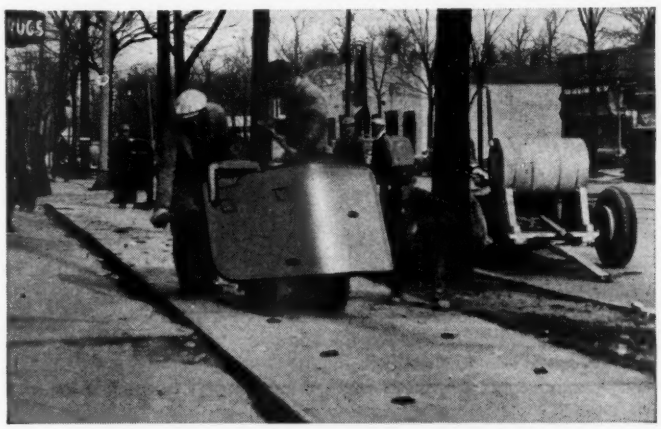

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the same because of the many factors which speed up or slow down natural purification processes. It is also impossible to say that the water will become clean in one day or one mile or any minimum period of time or distance for the same reason as above.

Purification Due to Storage

Storage reservoirs may result in improved quality of a water due to some reduction in color, a reduction in turbidity due to settling out of silt in suspension, and reduction in the number of bacteria. The concentration of bacteria in water generally becomes smaller when the water is stored in an impounding reservoir. This happens because there is not enough food for the bacteria, sedimentation takes place in the slow moving reservoir waters, or other large microscopic organisms eat the bacteria as food, and sunlight aids in killing those bacteria near the surface of the water.

At St. Paul, Minn. the water supply which is taken from the Mississippi River passes through a series of four lakes on the way to the treatment plant. It takes from three weeks to three months for water to flow through these lakes on the way to the filter plant. The reduction in total numbers of bacteria during this period varies from 35% to 90% according to the season of the year, while during the same time the reduction in coliform index varies from 96% to 99%. Since the coliform bacteria are similar to the typhoid bacteria, it may be seen that there is a great reduction in numbers of all intestinal bacteria during a long period of storage. Experimental studies at London, England, have shown that more than 99% of typhoid bacteria and cholera bacteria will die during one week of quiescent storage.

Storage generally results in a reduction in the numbers of bacteria that cause disease, but it will frequently permit the growth of algae and similar organisms which cause tastes and odors. These will be discussed later.

Responsibility for Watershed Sanitation

The responsibility for establishing general rules for the protection of watersheds is generally placed on the State Department of Health of the state in which the watershed is located. The enforcement of such rules may be the responsibility of the state agency, of the water department concerned, or of both.

Complete ownership of a watershed will give the water department the right to utilize that property as it sees fit. Thus it would be possible to prohibit any trespassing of any kind on land owned by a city as a watershed furnishing its water supply. Complete ownership of the entire drainage area, even on the smaller streams, is frequently too costly to be considered. In that case, some means of sanitary control are necessary to prevent pollution of the water supply.

The courts will usually recognize the necessity of protecting a watershed in the interests of public health even though this results in a limitation of the various individual property rights. This is shown in the following statement by the court in a case where the City of Golden, Colorado, sued the owner of cattle after the cattle had trespassed upon the watershed:

"It was not only the right, but also the duty, of the city to maintain the purity of its water supply for the domestic use of its inhabitants."

Thus the rights of the owner to pasture his cattle on the watershed of the city were not allowed since there was some danger to the health of the entire city.

There is quite a variation in the details of control and the amount of power vested in the various states. In general the state is given broad powers which it may in turn delegate to those municipalities which are large enough to share or assume responsibility. The authority of states can be shown by noting excerpts from the state laws of Minnesota:

"The board (of Health) may adopt, alter and enforce reasonable regulations, of permanent application throughout the whole or any portion of the state, or for specified periods in parts thereof, for the preservation of the public health. Upon the approval of the attorney general and the due publication thereof such regulations may have the force of law, except insofar as they may conflct with a statute or with the charter or ordinance of a city of first class upon the same subject . . . . . the board may control . . . the pollution of streams and other waters . . ."

"Section 5375. Pollution of Water. No sewage or other matter that will impair the healthfulness of water shall be deposited where it will fall or drain into any pond or stream used as a source of water supply for domestic use. The state board of health shall take general charge of springs, wells, ponds, and streams so used, and shall take all necessary and proper steps to preserve the same for such pollution as may endanger the public health. In the case of violation of any of the provisions of this section, the state board may. with or without a hearing, order any person to desist from causing such pollution, and to comply with such direction of the board as it may deem proper and expedient in the premises. Such order shall be served upon the person found to have violated such provisions."

The variation in the amount of control granted to the city may be shown by the examination of the practice of several states in maintaining sanitary conditions on watersheds which furnish surface water supplies. In Virginia the local officials are given adequate authority to prevent any pollution of a water supply where the watershed area is less than 50 square miles, and where the drainage area exceeds 50 square miles they are given jurisdiction over the stream for a distance of five miles above the intake.

In North Carolina the municipality or water company is required to make sanitary inspections four times a year of the entire watershed of any waterworks deriving its water from a surface supply if the minimum daily stream flow is less than 10 million gallons. If the flow exceeds 10 million gallons per day, this inspection shall be made over the 15 miles of watershed along the stream above the watershed intake. Extensive regulations have been adopted by the state, and are published as a bulletin of the Board of Health.

New York laws authorize the state health department to make rules and regulations for the protection of public water supplies from contamination. General rules have been established with reference to camps, swimming pools, and bathing beaches, and sewage treatment facilities. Specific rules have been established for the protection of individual public water supplies in the state. The local officials have the obligation for enforcing the rules, it being held that the owner of a water supply benefited should bear the expense of protecting that supply. These local water supply authorities have supervision over watershed areas even though the municipality or water company does not own the entire area. Thus sanitary inspectors may patrol the entire watershed without hindrance by individual property owners. This is in contrast to the situation in certain states, in which only representatives of the state department making these regulations have the right to make sanitary inspections on property owned by private individuals.

Officials of a water department or private water company who are interested in the improvement of the sanitary conditions of their own watershed must first study their state laws governing the sanitation and protection of watersheds. This study will show the legal right of local officials in patrolling a watershed. It will also let the local authorities know what meas-

ures they can insist upon to prevent pollution of the water supply. The rules and regulations which may be set up within the authority of the individual water department or company might well be examined to see if they are adequate and will provide proper protection to the water supply. If control measures are needed in addition to those authorized by the existing regulations, the state health department or the state agency with the legal right to establish such regulations should be consulted to see if the new rules can be established. In the meanwhile, the water official can seek the cooperation of the property owners in improving the sanitary facilities or in reducing the possibility of pollution.

An example of the cooperative method of improving sanitary conditions on a watershed is provided by Dallas, Texas. After constructing an impounding reservoir, the water officials wanted to replace unsanitary toilet facilities on the watershed with sanitary pit privies located and constructed in an improved manner. State laws did not give the Dallas authorities the right to establish rules which could be enforced in adjacent counties. An advertising program was instituted throughout the watershed, pointing out the advantages of improving the toilet facilities. Labor and a small part of the materials were furnished by the city at first, but the advertising was so successful that private property owners were soon cooperating in furnishing all of the materials and part of the labor required in building the approved type toilets. In the example shown, the city officials were able to improve sanitary conditions on private property so as to provide better sanitation on marginal land surrounding their impounding reservoir even though there were no legal regulations which could be invoked to force the property owners to cooperate.

Recreational Use of Watersheds

One of the most controversial topics relating to watershed sanitation is that concerning the recreational use of the watershed and the extent to which recreational activities should be permitted. In general it is considered that the health authorities and waterworks officials in the eastern states take a rather firm stand in opposition to extensive recreational use of the land which serves as a catchment area for a water supply. This is particularly true of the watersheds which are sparsely settled. On the other hand, in some of the western states, frequently in those areas where natural lakes and forested areas suited for recreational use are limited in numbers, many waterworks men have taken the viewpoint that recreational use of watersheds and sometimes of reservoirs will not endanger the health of those people who are supplied with water from that source as long as suitable safeguards are maintained. These safeguards consist of the maintenance of selected areas for recreational use, with all sanitary facilities provided to prevent pollution, and proper treatment of the water to insure that it will meet standards of bacterial quality.

In 1936, W. W. Brush, Editor of Water Works Engineering, in a paper read at the Southeast section meeting of the A.W.W.A. on obsolescence in water works equipment and operating methods said the following about the use of watersheds and of reservoirs for recreational purposes:

"Here we are immediately confronted with the controversial subject of whether the conservatism of the eastern water works men in trying to prevent the recreational use of water supply lands and reservoirs represents a method that is becoming obsolescent as compared with the view held by many western

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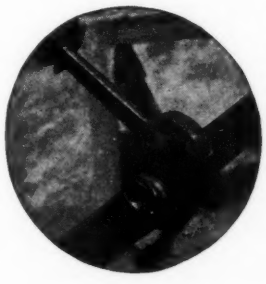

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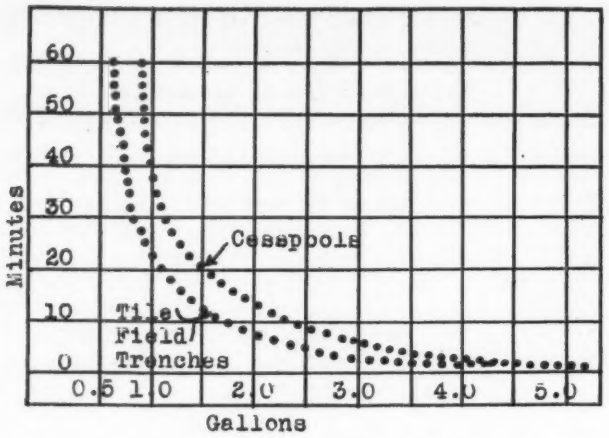
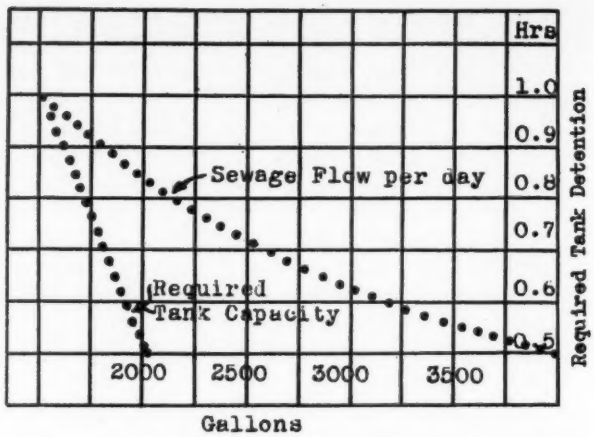


Curves of percolation rates for tile field and cesspool size determination.



Septic tank size: From sewage flow curve go left to tank capacity curve and down.

operators that such is not to be discouraged, provided the sanitary quality of the water is safeguarded by adequate treatment. It is the writer's belief that gradually the recreational use will tend to prevail even though the cleanliness standard of the domestic water supply is thereby lowered, provided the sanitary quality of the treated water is fully maintained." [1]

Recreational use of a watershed may include both the temporary use or occupation of the land on the drainage area, and it may also mean that people are utilizing the storage reservoir for pleasure activities. In those cases where there is not a large impounding reservoir, the problem arises of regulating the use of the land bordering the stream used as a source of water in order to keep the amount of pollution in the stream down to limits which can be safely handled by the treatment plant.

Each of the types of use or activity named brings its own problems of sanitation and may or may not be the source of harmful and serious pollution of a water supply. It is impossible to write a formula to express the allowable amount of pollution of a raw water in terms of the amount of watershed use that may be permitted. The element of chance is too strong to predict that a specified amount of pollution, measured in terms of the bacterial count of the raw water, is to be expected from each person who spends a few hours on watershed property. Even when ample and well-planned toilet facilities are provided, there may be some wilful and malicious act of pollution.

Speaking with respect to the public use of a watershed and storage reservoir in 1939, Holmquist and Cox of the New York State Department of Health summarized the main points involved in the question of watershed sanitation and recreational use:

"1. Any use of watersheds of reservoirs, the water from which is to be delivered without treatment, constitutes a menace to the health of the consumers of the water.

"2. All surface supplies should be treated (with chlorine at least) because of the inability to control completely the use of even uninhabited watersheds.

"3. The restricted use of inhabited watersheds of reservoirs of treated supplies is permissible, provided the degree of control, the effectiveness of self-purification in the reservoir, and the effectiveness of final treatment are coordinated.

"4. The restricted recreational use of inhabited watersheds and large impounding reservoirs and lakes does not appreciably increase the degree of pollution of the raw water or the degree of required treatment of the water.

"5. The sanitary protection of watersheds and impounding reservoirs is the first duty of water officials regardless of the subsequent degree of treatment of the water.

"6. An attitude of cooperation with the general public and owners of property on the watersheds, supported by appropriate laws and regulations, results in better protection than an attempt at rigid control of an uncompromising nature.

"7. Special rules and regulations protecting individual supplies are needed where watersheds are not owned by municipalities or water companies.

"8. Special staffs are needed for the adequate control of large watersheds where provisions are made to adapt administrative policies to local needs and interests of owners of private property, and where cooperation is designed to overcome antagonisms and secure the active support of the general public.

"9. Special control of typhoid carriers is essential." [2]

Some recreational activities are intermittent in nature and are such that those taking part roam extensively and individually over large portions of a watershed. These activities include riding, hiking, hunting, skiing, and picnicking. Where water works authorities permit or expect to permit such forms of recreation, careful planning is essential in order to provide adequate toilet facilities, and considerable supervision is necessary to insure use of the approved toilet facilities. These measures are essential since there is a certain small percentage of the population who are carriers of typhoid fever and other waterborne diseases.

One example of the strong attitude that is sometimes taken by Eastern water works and health officials against recreational use of a watershed is given in the policies of the Department of Public Health in Massachusetts. State laws permit public fishing in all ponds or natural bodies of water having an area of ten acres or more, these being designated as property of the Commonwealth in the colonial grants. There are some 1300 bodies of water of this classification in Massachusetts, about 200 of which are used as a source of public water supply. The Massachusetts laws also authorize the Department of Public Health to adopt those rules and regulations which it considers necessary to prevent the pollution of a water supply. This latter use is considered more important than the fishing rights and would be so considered in ruling on the use of public ponds. Because of the importance of the quality of drinking water, complete prohibition of fishing is usually enforced. Swimming in a body of water used for water supply purposes is also prohibited to keep out possible pollution. The Chief Engineer of this department has repeatedly stated his opposition to bathing, boating, fishing, and other forms of recreation in sources of public water supplies. It is felt that the low typhoid rate in Massachusetts is due to a large extent to the stern attitude taken on the subject of watershed protection.

The belief that the best method of maintaining a safe water supply is to keep any possible source of pollution off the drainage area is also found in other

[1] Brush, W. W., "Obsolescence in Water Works Equipment and Operating Methods," Journal, A.W.W.A. 28:207. 1936.

[2] Holmquist, C. A. and Cox, C. R., "Technical and Social Aspects of Watershed and Reservoir Sanitation," Civ. Eng. 9: 665. 1939.

parts of the country. The East Bay Water Co., of Oakland, California, obtains its water from a surface supply with a long storage period in an impounding reservoir. The water is filtered and chlorinated before use. The water company has jurisdiction over sanitary conditions and fire hazards, even on property not owned by them, by right of state authorization and through cooperation by individual property owners. This company has definite inspection and patrol programs to insure that approved sanitary requirements are met, this inspection covering the entire area of their watershed. Hunting, fishing, boating, and swimming are not permitted. Permits are required for anyone who wishes to enter the lands controlled by the company. These permits limit a person to a very strict behavior while on the watershed.

An illustration of a situation where full recreational use of a watershed and reservoir is permitted and even encouraged is furnished by Springfield, Illinois. When this city recently provided a new impounded supply, the plans called for the use of the lake for aquatic recreational activities, and for the use of the lands of the watershed for other recreational purposes. The use of the lake and surrounding area was encouraged by the creation of a number of lakeside parks, a picnic grove, a public boat dock, a beach and beach house. A pool was created by a breakwater into the lake, with recirculation of water for treatment with chlorine. One area was set aside as a wild life sanctuary, most of which is accessible only by trails. It includes part of the shoreline of the lake. The income which would be obtained from renting the land on the margin of the lake was estimated sufficient to maintain the area and leave a profit. These marginal areas were divided into plots which were leased not only for seasonal use, but also for permanent residential use. The lake is not to be used within a radius of 1000 feet of the intake. All boats are licensed so as to provide control over toilet facilities on the boats in order to prevent pollution of the lake water. All water taken from the lake is given complete treatment in a filtration and softening plant before going into the distribution system.

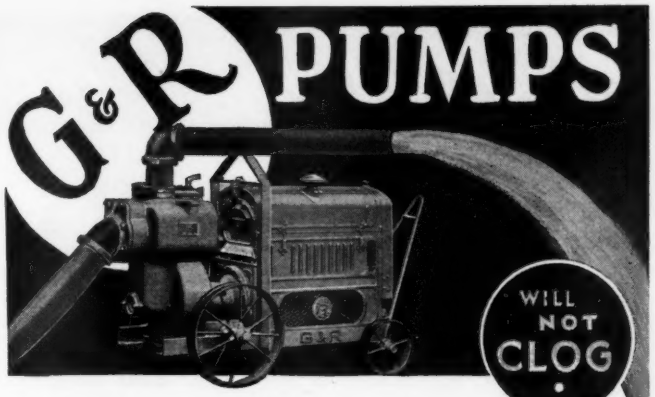
Sewage disposal for the areas adjacent to the lake shore is well taken care of. The major residential area is served by sanitary sewers which take the sewage to the regular sewerage system of the city, or to a small treatment plant built to serve the lake shore, the small plant discharging its effluent into an adjacent creek and drainage area. Where it was impracticable to build sanitary sewers because of cost, but where water was available, individual disposal plants consisting of small Imhoff tanks and tile disposal field are used. Where water carriage of sewage is not possible, septic toilets are permitted.

Fishing

While there is still no general agreement on the question of complete prohibition of fishing in impounding reservoirs or lakes used as a source for a public water supply, certain regulations which have been used in protecting a water supply may be helpful. The regulations outlined below are in part from those adopted by the North Carolina State Board of Health:

Fishing in water supply lakes or storage reservoirs should be under the control of the municipality that owns the supply. The municipality should establish rules regulating these activities in accordance with the general sanitary standards set up by the State Health Department.

Fishing should not be permitted in any body of water which has a storage period of less than 30 to 60



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days, based upon the maximum daily rate of consumption of water from the lake. In North Carolina the minimum storage is 60 days.

All fishing should be done from boats owned or controlled by the municipality. If the privately owned boats do not adhere to the requirements set up by the municipality, they should be removed from the lake.

Licences for fishing in reservoirs of water supplies should be issued with the stipulation that there will be strict observance of sanitary regulations, violation of which will result in suspension of the license.

Watershed inspectors should be available to observe the conduct of those permitted to fish, with power to arrest or otherwise control offenders who commit acts of pollution. Penalties should be imposed on offenders to insure compliance with the regulations set up.

Boating

Boating in small sail boats or motor launches is sometimes practiced on large impounding reservoirs. The use of boats on lakes and reservoirs may lead to the contamination of the water with trash, garbage and other unsightly material, and it may result in pollution from human wastes if the boats stay out from the shore for many hours. Neither the human pollution nor the tossing of litter into the lake is desirable. It would be well not to permit built-in toilet facilities in the motor launches, unless these were of an acceptable chemical tank type which could be removed to a safe point for cleaning. Boating within a distance of one-quarter to one-half mile of the intake should not be permitted. Where there are nearby natural or artifical bodies of water suited for boating and not used for water supply purposes, there would be little reason to permit use of the public water supply for this sport.

Picnicking

Picnicking in wooded areas appeals to many urban dwellers, but there may be a scarcity of suitable picnic grounds except on the watershed of a municipal water supply. Just as with other recreational uses of a watershed, there are objectors to the provision of picnic spots on watersheds. Yet many water companies and water departments are providing picnic areas where there may be full supervision over the activities of those who enter the watershed.

One municipality which provides these picnic areas is Newark, N. J. Here picnics are permitted in selected areas remote from streams or the storage reservoir. The city provides a parking area, picnic tables, fireplaces, wood for cooking purposes, and convenient receptacles for garbage and rubbish. Chemical toilets are used in the comfort stations. Uniformed guards are stationed at these picnic areas to maintain order and to insure that there are no abuses of the privileges given the picnickers. The City of Newark has found that more pride and interest in the operation of the water department is evidenced now than before the public was provided with recreational facilities by the water department.

When picnic areas are to be provided on a watershed, there should be ample provisions for the sanitation of the area. Toilet facilities should be located in or conveniently near the picnic area. These facilities should be so located and constructed that they will not pollute the water courses. It is rather difficult to estimate the exact number of toilet units to furnish, but usually one toilet for each 40 female persons expected at peak usage will be adequate. For men there may be one toilet and one urinal for each 60 men. The experience of the local park department might be helpful

in determining the number of toilet units needed.

An adequate number of receptacles should be provided for the disposal of garbage and refuse. These cans should be emptied at regular intervals and the waste material collected should be burned or buried with a cover of at least 2 feet and at a distance not less than 100 feet from any stream or waterway.

Safe drinking water should be available within the picnic area. This water should be under pressure with approved-type drinking fountains.

Miscellaneous Recreational Activities

At times, railroads will sponsor one day train trips known as "snow trains" or camera tours in which large groups of people will be taken away from cities for recreational purposes. If the stopover is made on a watershed, there is usually some need for special facilities for garbage and toilet wastes. Sometimes these stops are made where there are not extensive toilet facilities and where there is not enough use to justify expensive permanent toilet facilities. In cases like this where the New York Central Railroad ran ski trains to a point on the New York City-Catskill Watershed, the train toilets were not used in such a manner as to contaminate the nearby creek. Outside pit toilets, located well away from the watercourses, were constructed and used by the patrons of the railroad.

The location of railroads on watersheds near streams which drain into impounding reservoirs, or adjacent to the reservoirs themselves is a matter which needs attention. The customary practice in cases like this is to make arrangements with the railroad officials for all toilets on trains to be locked while passing through the watershed areas. In this way the dropping of human wastes onto the watershed so that pollution would be carried into the drinking water by storm runoff is prevented.

Sanitary Facilities on Watersheds

The more important provision for sanitation that is required on watersheds is the safe disposal of sewage. Less important as a cause of disease outbreaks, but still important from the standpoint of general sanitation, is the disposal of garbage, barnyard drainage, etc.

The basic requirement in the disposal of sewage is the prevention of sewage-laden water containing intestinal bacteria from reaching a watercourse or lake until after the bacteria are filtered out or until they have been killed by an unfavorable environment or by chemical treatment. The Los Angeles County Health Department has set up the two following conditions as essential in the disposal of sewage in rural areas:

"1. A downward percolation of sewage through at least a 10-foot depth of fine unsaturated material above the water table.

"2. A horizontal travel with the water table of at least thirty days before reaching any source of supply."[3]

It is assumed that the velocity of the ground water through fine sand or soil is about 10 feet per day, requiring a distance of about 300 feet of travel to satisfy the second condition. The 30-day period is generally long enough to insure the disappearance of intestinal bacteria carried in the sewage.

It is required in many states that all persons who plan to construct any sewage disposal facilities on a watershed must first obtain a permit from the health department having supervision of the watershed. Frequently the application for a permit will go to the water works officials who are responsible for the inspection of the watershed. In New York anyone constructing a toilet or sewage disposal plant on the water-

[3]Stead, Frank M., "Sanitation of Recreational Areas," J.A.W.W.A. 31: 714; 1939.

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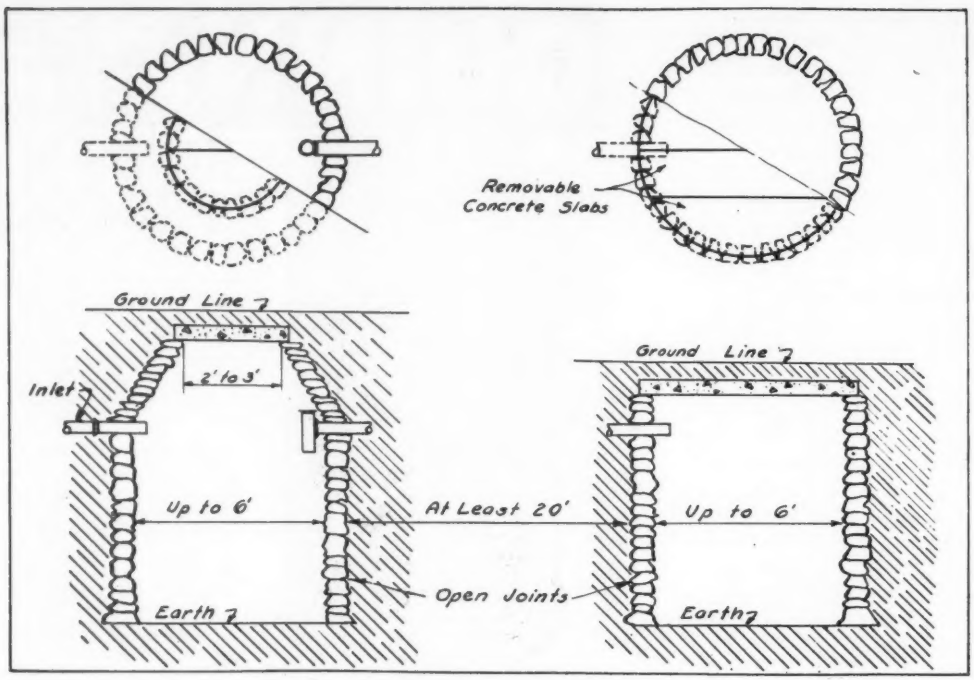


Fig. 2—Plan and section of leaching cesspools.

shed of any public supply must comply with the special rules set up for that particular watershed. In general a permit will require that:

No drainage from any privy, cesspool, sewer or sewage treatment plant shall flow directly into any lake, reservoir or stream unless the specific installation has been approved by the state health department.

No privy shall be located in the direct line of drainage of a water supply so that surface drainage can enter that water, nor less than 100 feet in a horizontal direction from any well, spring, or water supply intake pipe in a body of water used as a source of water supply.

Privies located from 100 to 200 feet from the source of a water supply shall be provided with water-tight vaults or receptacles. The contents of these privy vaults must be removed and disposed in a satisfactory manner when necessary. Satisfactory disposal is achieved when the vault contents are buried at a distance of 300 to 500 feet from the water's edge of streams or reservoirs.

Leaching pits for the disposal of excreta, cesspools, subsurface tile drains, sand filters, or other units of sewage treatment works shall not be located in the direct line of surface drainage into bodies of water used for water supply. The minimum distance from the water to any of these structures should be 200 feet.

In places where there is running water the types of sewage disposal facilities generally used are leaching cesspools, septic tanks or small Imhoff tanks with appropriate final treatment of the tank effluent. If running water is not available, or if the regulations established by the health department do not allow water-carriage of sewage, then pit privies, vault privies or chemical toilets must be used.

Those responsible for the control of a watershed should first familiarize themselves with the requirements of the health department as to minimum standards for sewage disposal. These standards will serve as a basis for any watershed rules to be set up. In some cases there may be no legal basis on which to set up standards for sewage disposal which can be enforced throughout a watershed. If this is the case, the water officials may still decide on desirable conditions and attempt to secure the cooperation of residents on the watershed through educational methods. An example of this method of securing improved conditions has been cited previously in the case of Dallas, Texas.

Leaching Cesspools

Cesspools may be used successfully only where soil is porous and conditions are favorable so that clogging of the surrounding soil will not occur quickly. They are advisable only for private residences or for comfort stations serving very small populations. As a rule, cesspools serve both as a settling and digestion tank and as a method of disposing of the liquid part of sewage. They are more satisfactory and have a longer life when they are preceded by a settling tank, such as a septic tank.

The diameter of the cesspool should not be greater than six feet. Two or more cesspools of this size in series are preferable to one of much larger size. The soil into which a cesspool is placed should be porous. It should be well-drained and not within the normal ground water table. The depth of the cesspool should not be great enough to reach to within two feet above the level at which ground water will stand in a test pit. The effective percolation area through which the liquids seep is the wall area below the flow line since the bottom clogs quickly. Percolation tests are advisable in determining the necessary size of the cesspool, and may be made as described below.

A percolation test may be made by digging a pit to one-half the depth to be used for the cesspool. In the bottom of the pit a hole 12 inches square and 6 to 8 inches deep is dug. This hole is filled with water and left to drain. While the hole is moist, it is filled to a

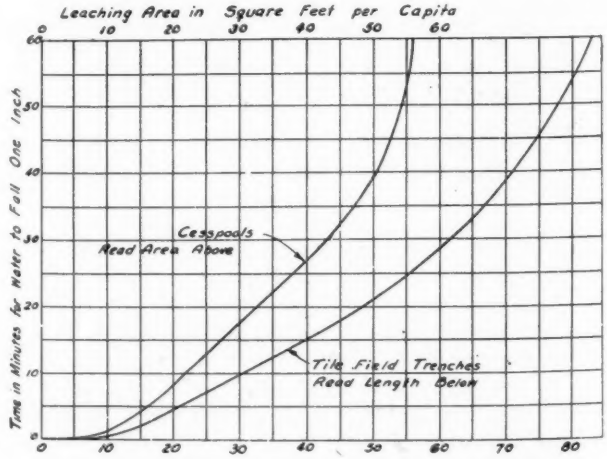


Fig. 1—Feet of 4" tile per capita with 12" trench width; at 50 gpd per capita.

depth of six inches and the time required for the water to fall one inch is observed. The percolation area required per person with a sewage flow of 50 gallons per capita per day may be determined from the curve in Fig. 1. For per capita sewage flows other than 50 gallons per day, the area required per person may be obtained by reading the curve and multiplying this value by the daily per capita flow divided by 50.

A cesspool should be lined with building stone, brick or building tile, or rubble masonry, laid without mortar. The lining should be strong enough to prevent the sides from caving in. The top should be covered, preferably with a concrete slab. Fig. 2 shows typical cesspool designs. The cesspool may be constructed with the upper portion corbelled to require a smaller cover, or it may have vertical sides to the top. Fig. 2 shows

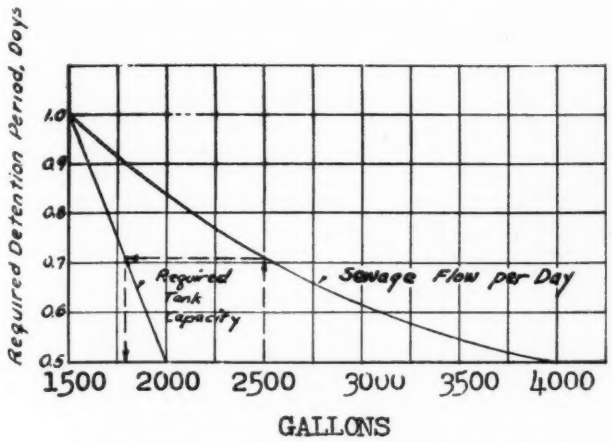
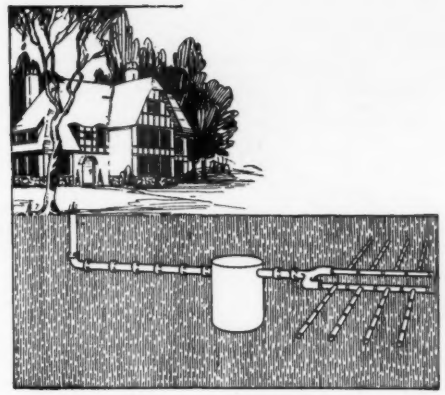


Fig. 3—Septic tank capacity for daily flows between 1500 and 4000 gpd.



San-Equip septic tank installation.

the arrangement when two tanks are used in series to increase the available percolation area.

Septic Tanks

A septic tank alone does not provide a very high degree of treatment for sewage, but is useful in removing the larger solids in sewage. This facilitates final disposal of the liquids by cesspools, subsurface tile systems or sand filters. The effluent from a septic tank cannot be discharged onto the surface of the ground, into ditches or into small streams without causing nuisance. Therefore, it is necessary to investigate the possibilities of disposing of the liquid overflow from septic tanks before deciding on their use.

The size of a septic tank should be equal in volume to at least one day's sewage flow, with a minimum capacity of not less than 300 gallons. This applies for daily sewage flows up to 1500 gallons per day. Above that capacity, and up to a daily sewage flow of 4,000 gallons per day the capacity may be reduced somewhat

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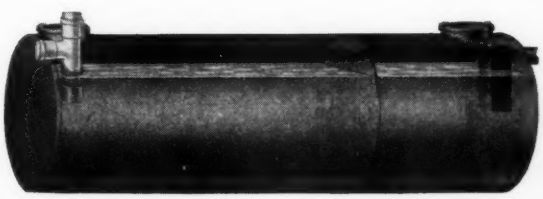

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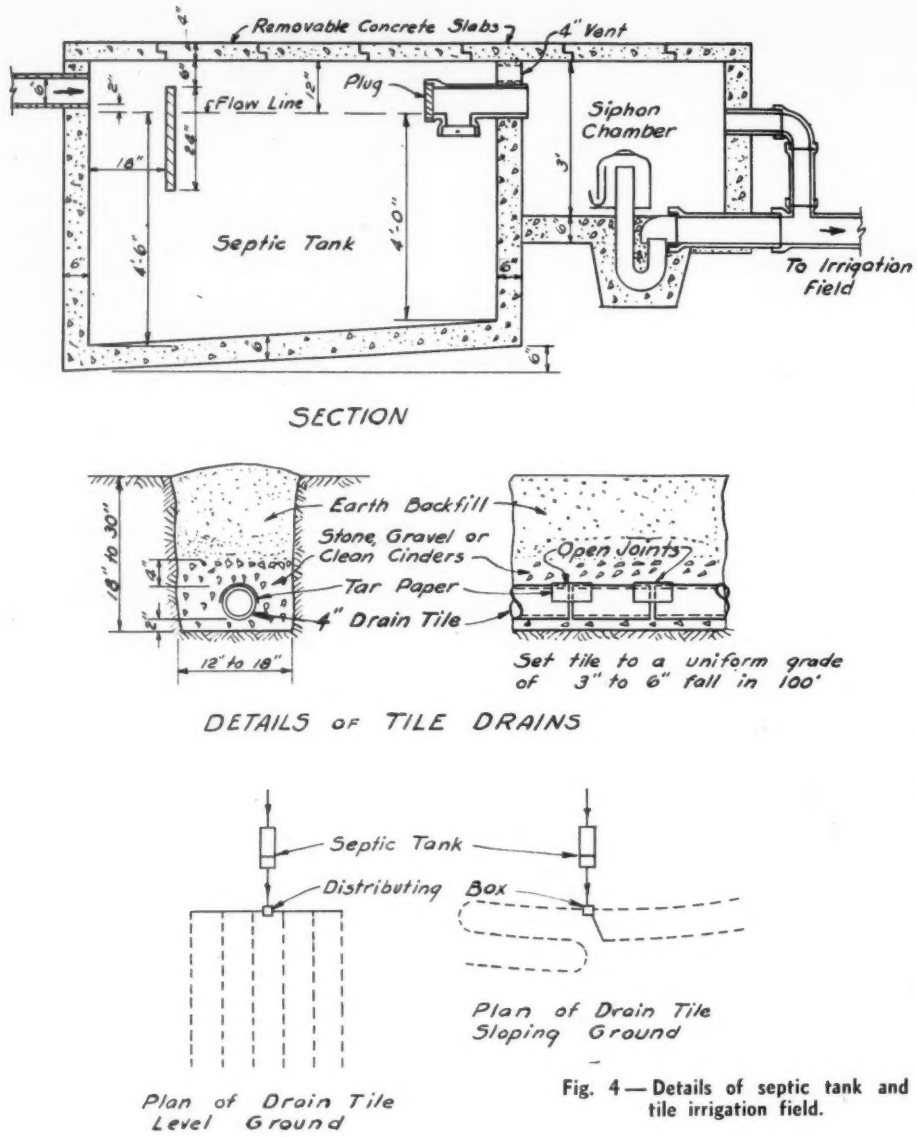


Fig. 4 — Details of septic tank and tile irrigation field.

with the increase in flow. With sewage flows of more than 4,000 gallons per day, the tank capacity should be equal to one-half the daily flow. The chart in Fig. 3 is helpful in determining the capacity for flows between 1,500 and 4,000 gallons per day. Typical designs of septic tanks are shown in Fig. 4.

The per capita sewage flow which must be used in conformance with State Health Department rules will vary from 50 to 75 gallons per day. Better results are to be expected generally with the larger design flow.

Subsurface Tile Drains

Subsurface tile systems which are used to distribute the effluent from a septic tank into the ground consist of main distributing lines leading to laterals composed of unglazed tile, four inches in diameter, laid with open joints on a slope of 6 inches per 100 feet. The tile is placed in a trench not less than one foot wide nor more than 3 feet wide and 18 to 30 inches deep, with lateral trenches 5 to 9 feet apart. The tile should be surrounded with gravel or broken stone from a level at least 2 inches below the tile up a level 4 inches or more above the top of the tile. Fig. 4 shows the usual method of constructing the tile drains. The main distributing lines should have tight joints, and should be on a slope of not less than 1 foot in 100 feet. The length of tile needed depends upon the type of soil. Percolation tests should be made, after which the amount of tile required per 50 gallons of sewage flow daily can be obtained from Fig. 1.

Dosing tanks, with automatic siphons, should be provided for the larger plants. The dosing tanks should have a capacity approximately equal to, but not greater than, three-fourths of the interior capacity of the pipe in the portion of the subsurface tile system which is dosed at one time. Where automatic siphons are used, facilities should be provided for dosing only part of the tile field at a time. The remainder of the tile field will have an opportunity to dry out somewhat during the time when it is out of service. In general, when the total length of lateral tiling exceeds 1,000 feet, the dosing tank should be provided with two siphons. These siphons are to operate alternately, each serving one-half the tile field.

Artificial Subsurface Sand Filters

Sometimes the soil is too dense to allow underground seepage of liquid from tile fields or cesspools. If there is some suitable watercourse or ditch that may be safely used as an outlet, it may be possible to use subsurface sand filters for the secondary treatment of tank effluent. The area of sand surface that is required is calculated from the average daily sewage flow, using a rate of filtration not greater than 50,000 gallons per acre per day. The area of filter required per capita for various rates of flow may be obtained from Figure 5. The filter sand should be clean, coarse sand which passes a ¼-inch mesh screen, and having an effective size between 0.25 and 0.5 mm. and a uniformity coefficient not greater than 4.0. For small installations, having a required area of sand not more than 400 square feet, a filter trench three to four feet wide may be used. For larger areas, a rectangular filter bed with a system of distributing and underdrain tile will be required. Details of subsurface sand filters are illustrated in Fig. 6. In general, there is a 30 inch depth of sand, with open joint underdrains, surrounded by gravel, for the collecting system, and with similar lines of open joint farm tiles used for the distributing system. The sand filter is covered with 6 to 12 inches of topsoil after the tile lines are in place. More complete details of such installations may be found in bulletins furnished by State Health Departments.

Sewage Disposal Without Water Carriage

In some cases there is necessity for toilet facilities in places where there is no running water available.

Many of the farm residences located on watersheds will be without running water and will have need for outdoor toilet facilities. In those cases where this type of toilet is required, there may be either some type of privy recommended, or chemical toilets may be used. The type of privy may depend upon the location with respect to water courses and upon the prevailing watershed regulations.

A pit privy should be located so that the natural drainage does not run from the privy into a stream or other source of water supply and it should be at least 100 to 200 feet away from such source of water supply. The pit should not be deep enough to penetrate the ground water table. The design of the pit privy should follow the recommendations of the State Health Department.

Pit for Manure Storage

Where barnyard wastes are found draining into a stream or reservoir in such a way as to create undesirable pollution, it may be necessary to construct a manure pit in which storage will be possible without consequent surface drainage into a watercourse. It is sometimes specified in watershed rules that no hog

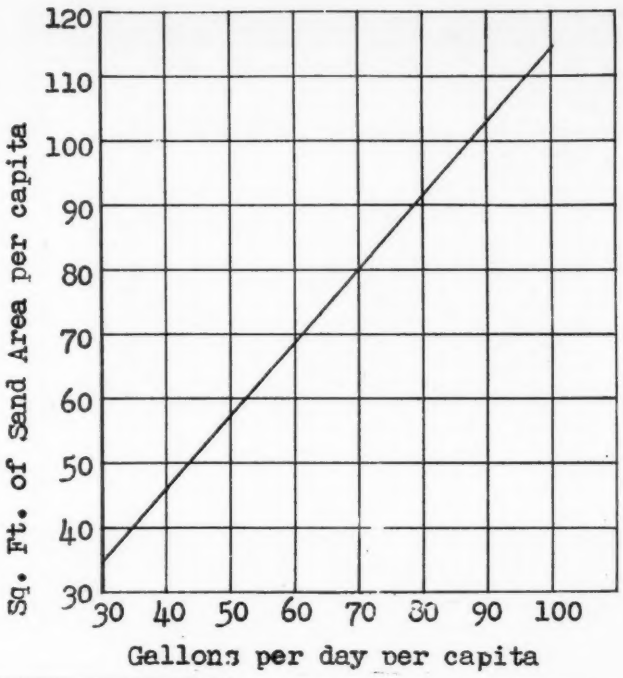
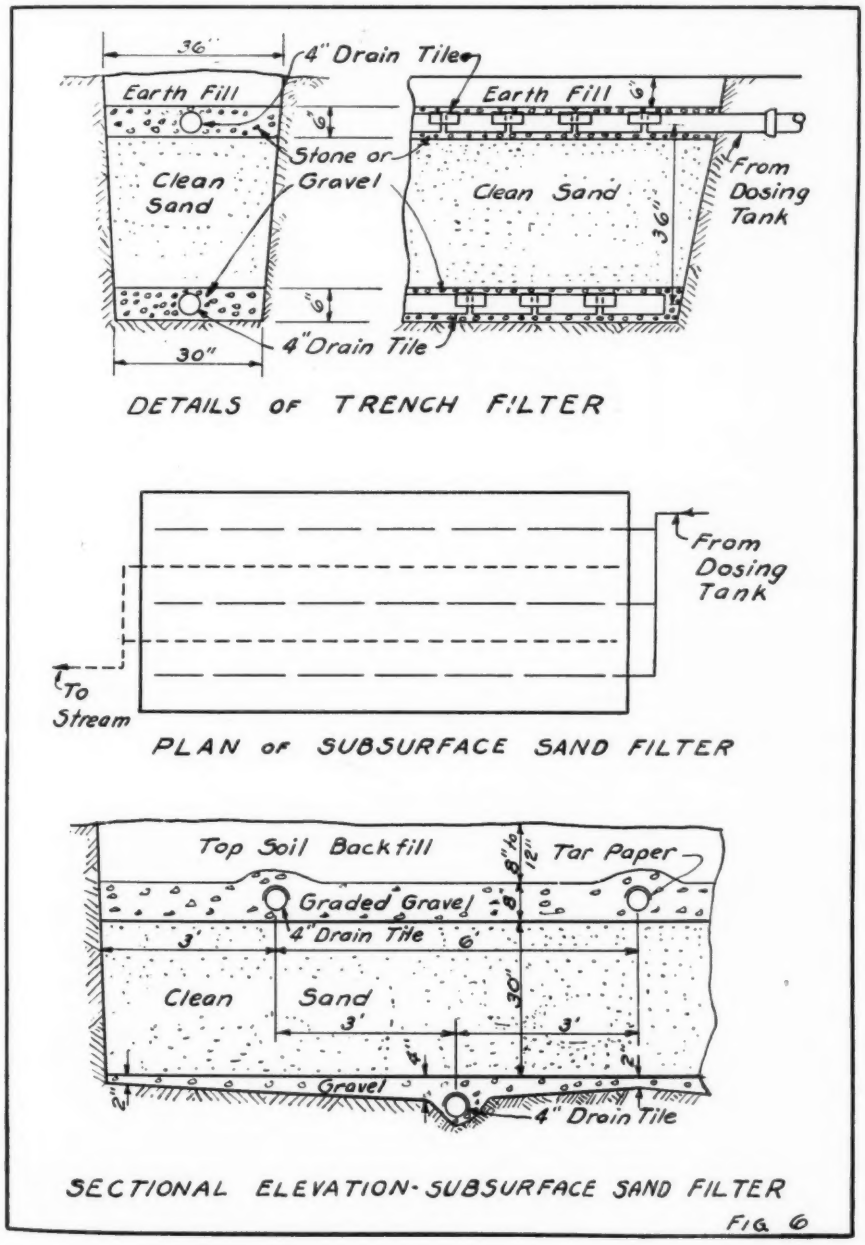


Fig. 5—Area of sand required per person with subsurface sand filters.



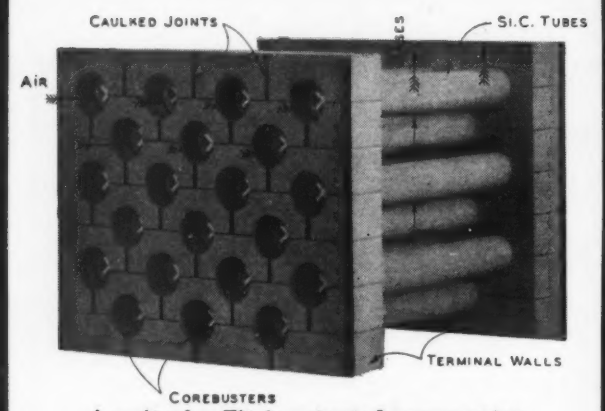
pen, cattle pen, horse or mule lot, poultry house, hitching or standing place for horses or cattle, or any other place where animal manure collects shall be permitted within 300 feet of streams or lakes used for water supply purposes, unless provisions are made for proper treatment. This rule is generally applied to marginal land within a certain minimum distance of the waterworks intake, as for example, five miles. When such pens or places where animal manure may collect are located near the water within the restricted distance above an intake, all accumulations of manure and other decaying matter should be removed at least once a month to some point farther from the water's edge.

A manure pit designed to prevent storm drainage from washing over manure piles and on into lakes or tributaries has been developed for the Syracuse, N. Y., watershed.[4] The essential features are shown in Fig. 7.

Sanitation for New York City Watersheds

New York City has had to develop new sources of supply several times to take care of the growth of the city. In practically every instance this need for more water was met by developing surface supplies. These surface supplies are obtained from inhabited watersheds, with a number

[4]Gregory, A. F., "Protection of Watershed for Syracuse Supply," J.A.W.W.A. 32: 555,1940.



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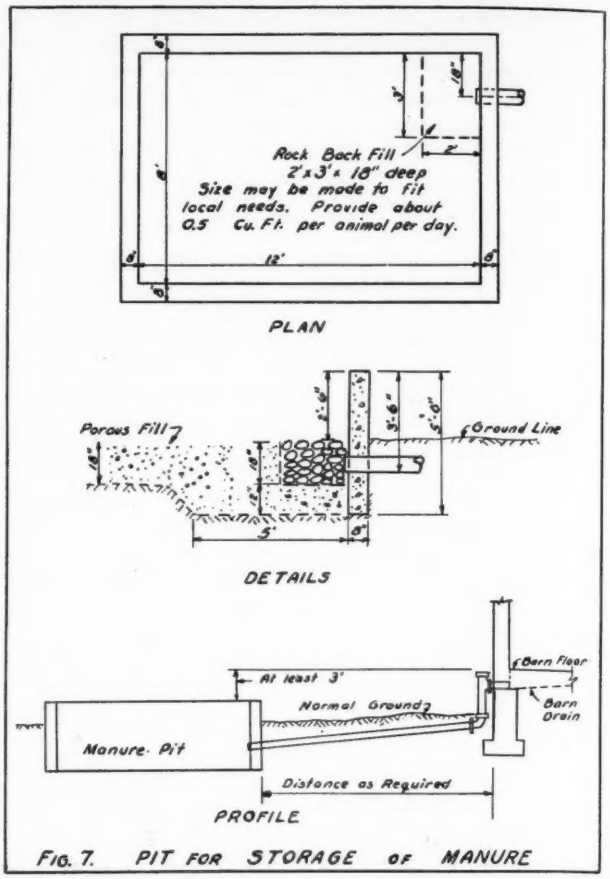

FIG. 7. PIT FOR STORAGE OF MANURE

of villages and institutions located on them. In order to safeguard the quality of the water obtained from these watersheds, the Board of Water Supply makes a detailed sanitary inspection of the entire watershed during the planning of the project. When the city is ready to start construction operations in developing a new source, all sources of pollution which have been previously located during the sanitary inspection are removed. In their place are substituted new facilities which meet the rigid sanitary requirements of the Board of Water Supply. Watertight privies, suitably located with respect to stream or impounding reservoirs, or chemical toilets are used in some cases. In other locations, properly designed and constructed domestic and institutional sewage disposal systems are used. Complete treatment facilities are provided for municipalities and for offensive industrial wastes when needed.

Policing and Patrolling

Watershed control will be more successful if there are inspectors with police power on patrol duty on the watershed. The establishment of regulations governing the use of watershed property may be meaningless without suitable provisions for the enforcement of rules. In many states the sanitary inspectors or patrolmen are authorized to enter upon any premises and into any building upon their respective watersheds for the specific purpose of making the inspection required. The duties of a watershed patrolman are varied. The primary duty is to locate sources of contamination and pollution so that they can be removed.

It is helpful to have a map of the watershed on which is recorded sources of pollution or contamination. There should be notations on the map to show all sewer systems, industrial plants, mines, private

sewers draining from houses or septic tanks, etc. It is also desirable to note the location of all toilets and privies, with distances from them to any nearby stream or watercourse. This map can be used in planning the routes to be followed by watershed inspectors. Pins or symbols may be used to denote dangerous points on the watershed which need frequent inspection or correction. Other symbols may be used to designate potential sources of pollution which require periodic inspection.

It is fairly common practice to construct a road around a water supply reservoir, the road being constructed above the high water line. A road around the reservoir makes it easier for patrolmen to drive around the lake to check on undesirable or illegal use of the lake. Dead animals, floating debris, and other materials which should be removed from the reservoir may be seen easily from such a road. The road is also suitable for use as a recreational drive. The area between the road and the edge of the water should be cleared of unsightly under-brush; it may be landscaped with trees and shrubs with good effect. Occasional neat signs should be posted along the road, if it is used for a recreational drive, stating that the reservoir is a public water supply. The signs should point out the fact that the quality of the water is protected by suitable regulations, and that the cooperation of visitors on the watershed is required.

The check on sewage disposal facilities includes the inspection of the premises of residences to determine the condition of privies, cesspools, septic tanks, etc. If there are regulations governing the location and construction of new facilities, an inspection may be made during construction to see that there is compliance with the regulations. The inspector while visiting any residence should note the general cleanliness, including accumulations of garbage, etc. Any barnyard manure piles or drainage which might contribute materially to the pollution of a water supply should be noted and instructions given for the removal of such sources of pollution if they are considered harmful. When dead animals are located adjacent to a reservoir or tributary stream, or within the water, steps should be taken to have them removed and buried at least 300 to 500 feet from the water.

The inspection of dwellings on a watershed to determine the adequacy of sewage disposal facilities is usually a routine check, to determine if there are any unusual conditions which need remedying. The toilet or other means of sewage disposal should be noted as to its state of repair and adequacy of size. The toilet and its immediate surroundings should be examined as to the distance from the water's edge, the slope of the land, and the character of the soil. There should be no conditions existing which do not come up to the standards set by the watershed regulations. When unsatisfactory conditions are found, the inspector should give instructions for their correction to some responsible person on the property. A full report of the inspection and violation should be made to the watershed officials, and to the Health Department where it has jurisdiction.

Watershed Inspection for New York City

The Department of Water Supply, Gas and Electricity operates the water supply and distribution system for New York City. When a watershed has been turned over to this operating department of the city by the Board of Water Supply, all sources of pollution from inhabitants of the watershed have been located and corrected. In order to prevent the break-

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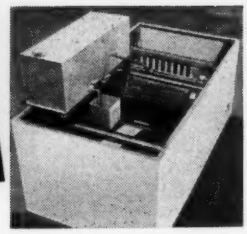

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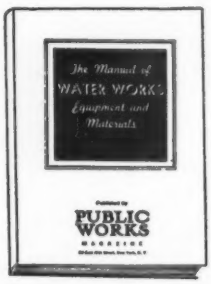

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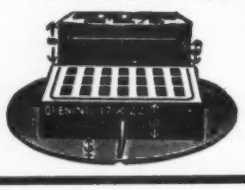

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down of sewage treatment facilities which have been installed, or to prevent the creation of new sources of pollution, a continuous sanitary inspection of the watershed is maintained. Experienced inspectors cover planned routes at frequent intervals, inspecting at weekly intervals, if possible, all occupied premises adjacent to the watercourses on the watershed. These inspectors are constantly on watch for acts of pollution by hunters, fishermen, or others visiting the watershed. Cases of typhoid or other water-borne diseases occurring on the watershed are investigated by the inspection force. The department works in cooperation with the local health authorities in such cases, taking all steps necessary to insure against pollution of the water supply. When new buildings are proposed on the watershed, the owners are advised regarding the proper methods for the safe disposal of wastes.

Collection of Water Samples

Many water companies or water departments collect frequent samples of water at various points on their watershed as part of the regular patrol procedure. These water samples are carefully taken in sterile sample bottles and are tested in the laboratory for bacteria which would indicate sewage pollution. The Hackensack Water Company, which serves 400,000 people in 51 New Jersey communities, collects samples from over 90 points on the various streams draining into their reservoirs. These samples are taken at points where there is danger of pollution arising from faulty sewage disposal or from other pollution. Any samples which show an undue amount of bacterial pollution would indicate the need for more careful inspection of nearby residences and sources of sewage pollution. The Hackensack Water Company maintains continuous patrol and sampling on their watershed although the water is completely treated in a filtration plant.

Typhoid Fever Cases

When a case of typhoid fever occurs on a watershed care should be taken to see that there is no contamination of any streams in the watershed with typhoid organisms. Cases of typhoid fever are reported to the Health Department by the attending physician. There should be some agreement between the officials responsible for watershed protection and the health department so that immediate steps may be taken to safeguard the water departments supply. Tulsa, Oklahoma, water department officials try to have all typhoid fever cases removed from the watershed until recovery. This step may not be necessary in all cases but is generally desirable. Also, there should be an inspection made to see that safe procedures are used in disposal of bodily wastes. This includes the disinfection of the body wastes with chloride of lime, a cresol solution or formaldehyde solution.

Some persons recovering from typhoid fever become carriers of the organisms. These carriers discharge typhoid bacteria in their body wastes either at intermittent intervals or almost continuously even though they do not show symptoms of the disease. Known carriers are supposed to be registered with the State and local Health Departments. Watershed officials should know of the presence of such carriers as residents on a watershed. It would be preferable to exclude known carriers from residence on a watershed.

SPECIAL PROBLEMS

Problems of a temporary nature occasionally arise in connection with the administration of watersheds. Some of these problems include construction work on

the watershed, ice-cutting on reservoirs or ponds in some of the northern states, saltwater pollution of surface water supplies, logging operations, etc. Where these activities are annual occurrences lasting short periods of the year, some definite policy may be created regarding the measures needed to protect the water supply. Other problems may be of a more rare occurrence and will require special study and special provisions for the sanitary protection of the water supply.

Construction Camps

Railroads, highways, power lines, pipe lines and other extensive engineering projects sometimes are located so that they pass through or are located on the watersheds of public water supplies. These construction projects may require the use of camps in which the personnel engaged in the construction work not only work on the watershed, but establish living quarters there in which they reside for some lengths of time. In other cases the center of construction operations requires the concentration of large crews of workmen on the watershed during work hours. These locations may be of a more or less temporary nature, but some adequate and safe means of handling toilet wastes must be employed, or serious pollution of the water supply may occur.

In many cases there are standing regulations which require that any organization which plans to engage in activities on a watershed involving the presence thereon of a group of persons first secure permission from the responsible authorities, which permission is granted on the condition that adequate sanitary measures will be taken. These usually include disposal of sewage and other wastes in such a way that no pollution or contamination of watercourses will occur.

The construction of the Delaware River Watershed project of the Board of Water Supply of New York City involves the use of large construction forces on lands which are watershed drainage areas. There is the problem of disposal of both sewage and the tunnel drainage which is pumped to the surface of the ground for disposal into some water course. For sewage disposal, the Board of Water Supply uses septic or Imhoff tanks, with automatic dosing tanks distributing the tank effluent on intermittent sand filters. The filter effluent is usually chlorinated. The water which is pumped from the tunnels is passed through the sedimentation basins and is chlorinated before it is discharged into a stream. Tunnel muck which is brought to the surface during construction is treated with chlorine as a protective measure.

Ice Cutting

In some of the northern states where winter temperatures are low enough to permit the formation of thick ice on ponds and lakes, ice is frequently cut and stored during the winter months. In some instances ice is harvested from bodies of water used as a source of water supply. Since disease causing bacteria will live for long periods in ice and in cold water protective measures are needed to insure the quality of the water supply.

During the winter of 1940-41 the Massachusetts State Department of Health issued the following requirements as conditions to be met where permits were

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granted for ice cutting on water supply sources:

"(1) That no ice be harvested and that no workmen be permitted to approach nearer than 250 feet from the water works intake.

"(2) That no animals be driven upon the ice.

"(3) That suitable facilities for the reception, collection and disposal of urine and excreta and other wastes of those employed shall be provided, that such facilities shall be equipped with watertight containers, that the contents of such containers shall be removed from the watershed and disposed of in the public sewers under the supervision of the water works superintendent, and that the expectorating and depositing of any other polluting materials on the surface of the ice or in the water of the pond shall be prevented.

"(4) That all harvesting of the ice be under the direct supervision of an authorized representative of the Board of Water and Sewer Commissioners of the town of ..... in accordance with the rules and regulations adopted by this department under date of .....

"(5) That all water supplied from ..... be adequately chlorinated during the ice harvesting operations and for such additional time thereafter as may be determined by the Department of Public Health and that no ice-cutting shall be begun until suitable chlorinating apparatus has been installed and shown to be operating satisfactorily.

"(6) That the Department be informed twenty-four hours in advance of the time when ice-cutting is to be started and that it be advised immediately after the ice-cutting has ceased."[5]

Swamp Drainage

Watersheds sometimes contain swampy areas which contribute color to the water and which provide breeding places for mosquitoes and for micro-organisms that cause taste and odor in water. Color in swamp waters generally is caused by tannic acid or humic acid and the vegetable dyes from decomposing leaves and similar vegetable matter. If the swampy area is drained, substances causing color will not so readily leach from the soil and subsequently drain into the water supply. Many swamps may be drained in an economical manner by ditching and by cleaning the channels of small streams. These should be drained as far as possible to prevent the existence of stagnant bodies of water. When the drainage of swamp areas cannot be accomplished without large expenditures, a study should be made to determine the probable objection from colored water seeping from the swampy districts. Even more attention should be given to the probable effect of swamp drainage on the numbers of micro-organisms reaching the water supply and on the problem of mosquito control. In some cases it may be more economical to control micro-organisms that produce taste and odor by eliminating the sources, thereby reducing the cost of chemical control. Swampy areas should be drained or filled. Areas where shallow pools of stagnant water occur should be eliminated by deepening, filling, or by cutting a channel so that a current of fresh water will pass through the area. Stagnant and swampy areas may be surrounded by dikes, to cut them off from the water supply, but this procedure is not generally wise for it encourages the breeding of mosquitoes.

Preparation of Reservoir Site

The preparation of a reservoir site before use is a matter which has considerable bearing upon subsequent maintenance of the reservoir. The vegetation should be removed from the area to be flooded by a proposed reservoir to prevent its decay and consequent effect on the quality of the water stored. This includes the cutting of all trees and bushes close to the ground over the entire reservoir area. Shortly before the reservoir is filled all grass, weeds and shrubs should be burned.

The sides of the reservoir should have relatively steep slopes to prevent the occurrence of numerous shallow areas as the water level changes in the reservoir. The existence of shallow areas favors the growth of algae and other micro-organisms which cause taste and odor problems. Water weeds also grow easily in the shallow areas, later dying and decaying when the reservoir is refilled.

[5]Water Works Engineering, 94:133; Jan. 29, 1941.

REFORESTATION

Reforestation of watershed lands is generally accepted as a wise practice. There are a number of beneficial results to be obtained from a well planned program of forestation. Even though the water department has control of only a limited marginal strip surrounding its impounding reservoir, there are sufficient benefits from a tree-lined reservoir to warrant the practice of reforestation.

If the watershed or a portion of it in the form of a marginal strip around the reservoir is used for farming, it involves plowing the soil annually and results in unsightly erosion. This in turn increases the amount of turbidity in the reservoir, and shortens the life of a reservoir, because of increased silt deposition. If the impounding reservoir is small with a short storage period, there is much likelihood that the raw water turbidity will be high after each rainstorm, requiring filtration to produce water with a satisfactory appearance.

It is possible to plant the marginal areas in grass, but there is no income from sodded areas unless used for the grazing of sheep and cattle. This is undesirable because surface runoff from pasture lands results in high bacterial counts. Santa Fe, New Mexico, which uses an impounded surface water supply, noted a very marked reduction in bacterial numbers in the stored waters following the elimination of grazing on the unforested portions of the watershed.

Forested watersheds are desirable not only because of the decreased erosion which results, but also because they tend to prevent a rapid runoff after a rain, thereby conserving the rainfall to give a more evenly distributed runoff and a more uniform stream flow.

The practice of forestation of a watershed is one which may result in a profit. Some water departments utilize watersheds for the production of Christmas trees, securing sufficient income to support a nursery and to meet the costs of replacing cut trees. Others maintain forests by cutting selected trees annually for timber, allowing natural replacement to take place from the growth of seedlings resulting from the seeds which fall annually from most species of trees, or in some cases replacing cut trees from nursery stock.

The species of trees which will be most successful on a watershed will vary because of differences in climate, soil, elevation, etc. In general, conifers are considered desirable since the fallen needles form a layer which does not wash into the water easily to cause color troubles as in the case with many of the hardwoods. Also, the soft wood of the conifers is better from a commercial standpoint. The types of trees that are considered suitable for various regions of the country can be shown by noting the species used by various water departments.

The water department at Scranton, Pa., has practiced reforestation for many years. In their experience, white pine has not been too successful because of attacks of weevils and the danger from blister rust. Red pine gives good results where soil is not too barren, while scotch pine and the Pennsylvania pitch pine grow satisfactorily on the more barren soils. Norway and white spruce did not prove very satisfactory. Euro-

pean larch did well if the severe winter weather did not kill it during the first few years after planting.

Baltimore has made a practice of using white pines for reforestation purposes on their watershed. Where there are no trees, grass is planted in the open fields owned by the city to cut down the amount of silt pickup in surface runoff.

Springfield, Illinois, obtained a new source of supply a few years ago. The marginal area around the impounding reservoir was largely land which had been in cultivation prior to purchase by the city. Sod was immediately established by planting timothy, rye, blue grass and other grasses. The areas of marginal land which were to be devoted to residential or park uses were planted largely with native hardwoods. The more remote areas, and those unsuited for residential uses were planted with various conifers, in places with densities up to 1,000 trees per acre.

St. Paul, Minn., has maintained a practice of planting several thousand evergreens annually on its watershed since 1914. The varieties of trees are: Scotch, Norway, Riga, White and Jack pines; Blue and Black Hills spruces; cedar and balsam firs.

In Ohio it has been found that one or more of the following species will usually grow on the barren soil that is frequently found: red, white, Scotch, Austrian, Corsican and short-leaf pines, Norway and white spruce.

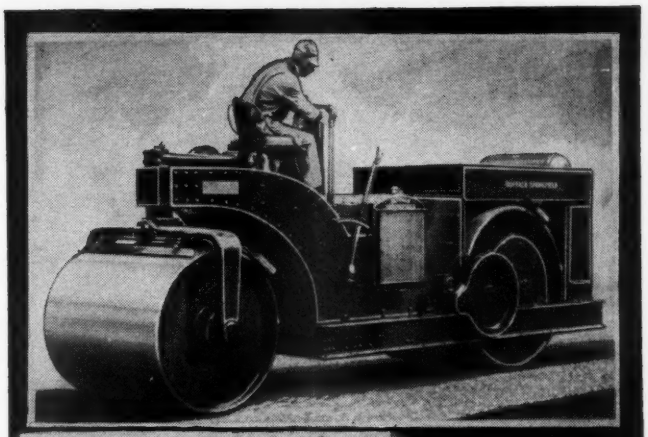
Where planting is used to maintain the stand of trees on a watershed the procedure will generally follow that below. The trees can be grown in a municipal or water department nursery to a size suitable for permanent planting, usually at an age of 3 or 4 years. Also, most states have a Forestry Department which maintains nurseries and can furnish small stock 1 to 2 years old which can be planted in a departmental nursery until suitable for permanent planting, and which sometimes can furnish trees ready to plant permanently. Private nurseries can also furnish trees of any size desired.

Trees should be planted originally with a spacing of 5 to 7 feet each way, which will require from 1,740 to 900 trees per acre. There will be some mortality of the newly planted trees, varying from 10 per cent of the trees planted in good condition up to 50 per cent in exceptional cases. Springfield, Illinois, reported that there was a loss of about one-half of the trees set out on its watershed during the first year or two. The average total loss should not exceed 20%.

The important consideration in planting trees on a watershed in a reforestation program is to consider the drainage of the area to be planted. Most of the trees mentioned here do not grow well in heavy soils, and all require a soil that has fairly good drainage.

Control of Tastes and Odors

The control of tastes and odors is desirable since water which is offensive to the senses of tastes and smell is not well received by the consumers. Water of this character tends to turn the consumers to other sources for drinking water, some of which may be unsafe. Taste and odor conditions may be the result of a number of conditions, and since the control measures must be based on the nature of the taste and odor producing substances, it is necessary to determine the cause of the unpleasant conditions before attempting correction. Taste and odor complaints have been caused by sewage pollution, growths of micro-organisms in reservoirs, by one or more of many industrial wastes, by high mineral contents, etc.



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Mineral Matter and Salts

Some waters contain sufficient quantities of minerals or salts as to be objectionable as drinking waters. When there is a high iron and manganese content in the water, there may be a bitter taste to the water, which would require removal of the iron and manganese for correction. A high chloride content gives water a brackish taste which cannot be removed by the usual methods of treatment, although a recently developed zeolite which will remove chlorides and other salts is now available. At the present time this carbonaceous zeolite has been used only in industrial water treatment. Some surface water supplies have been polluted with salt water from oil wells, notably in Texas and the mid-continent oil-producing states. It is necessary to exclude the waste brines from streams used for water supply for the elimination of this form of pollution. Present methods of control consist of returning the brine to the ground, piping it to the sea, evaporation in ponds, or storage in ponds for controlled release into surface streams during times of high discharge.

Sewage and Industrial Wastes

As a rule there is no odor trouble with waters which have had a small amount of sewage pollution. It is the general policy of health authorities to insist on sewage treatment to minimize the amount of sewage pollution which will be present in water supply sources. However, there are cases in which serious taste and odor problems have been due primarily to domestic sewage pollution. Industrial wastes cause tastes and odors in water which are typical of the type of waste. Troublesome industrial pollution may be caused by coke plants, paper mill wastes, canneries, oil refineries, tanneries, and various chemical plants. The best method of control is the elimination of waste materials from streams, but this is not always done without considerable delay. The wastes from gas plants and from coal distillation plants are especially troublesome because of the phenol present in such wastes imparts distinct tastes to the water which are accentuated by chlorination. Phenol in the small amount of one part to 500 million parts of water has been detected as a medicinal taste after chlorination. Activated carbon treatment of the water may be effective in removing taste and odor caused by these substances pending the elimination of them.

Algae and Other Microscopic Organisms

The greatest number of taste and odor problems in water supplies secured from surface waters are caused by microorganisms growing in the reservoirs. The best control measure is the elimination of these organisms or the destruction of them in the reservoirs. The application of control measures for the elimination of these organisms sometimes results in taste and odor production for a short time after the destruction of the organisms. In such cases the water may be treated with activated carbon, with chlorine in adequate amounts, or with chloramines. Identification and control of microscopic organisms will not be considered here, but may be the subject of a later complete article.

Control of Aquatic Vegetation and Weeds

Aquatic vegetation or water weeds are undesirable in reservoirs for several reasons. They may grow so profusely as to create a nuisance by their abundance. Where they are only partially submerged they may provide harborages for mosquitoes to breed in. Aquatic plants afford shelter for the protozoa and other organisms which live upon the organic material that accumulates in the protected waters of such growths. Some plants that die and decay in the water furnish food for organisms. Aquatic vegetation found frequently in reservoirs includes Chara, water lilies, eel grass, duck-weed, etc.

Water vegetation may be removed by dewatering, dredging, cutting and dragging. Lowering of the water level during hot weather to expose water weeds will cause them to die, but usually it is not desirable to drain a reservoir during the summer other than to supply the normal demand for water. Exposed areas frequently become covered with land weeds when the water is down, these weeds dying when submerged to decay with resulting unsightliness and sometimes color and taste troubles. Therefore, dewatering of reservoirs to uncover aquatic vegetation frequently leads to profuse growth of land weeds and accompanying troubles. Dredging will remove both the growing plants and their roots, preventing the plants from springing up again the following season, but frequently it is neither desirable nor feasible to dredge in reservoirs. The more common methods of removal are by cutting and dragging as described below.

Water weeds may be cut near the roots by use of an underwater saw similar to a steel band saw, having cutting edges on each side and a blade length up to several hundred feet long. When in use the blade is kept on the bottom by means of weights attached at intervals along the blade. The saw may be operated by one or two men at each end, working from shore to a raft or boat, or working from two boats. Cut vegetation will rise to the surface, drifting ashore with the wind or it may be picked up in boats and carried ashore for disposal. A successful method of cutting underwater plants has been developed in Texas utilizing a cutting blade attached to the front of a flat-bottomed boat.[6] The boat is propelled by an outboard motor through areas to be cleared of vegetation. It is reported that a path of from 50 to 150 yards can be cut before the propellor clogs.

Land weeds along the shore may be destroyed by cutting, by burning, or by oiling. Perhaps the best method of keeping the weeds down is by use of a portable weed burner which throws a hot flame several feet from the workman, quickly searing the growing vegetation. This method leaves only the burned remains of the weeds which should not impair the quality

of the water. Oiling as a method of control has been practiced by the Los Angeles Water Department which has found that the land vegetation which springs up around a reservoir as the water level is drawn down may be controlled by spraying with diesel fuel oil. This has been done for some years without subsequent taste and odor troubles in the water due to the oil. Common weeds treated in this manner include wild rice, tules, sour dock, etc. The quantity of oil used for spraying an area was about 125 gallons per acre per application during the first year of treatment, with a reduction during later years. Spraying was repeated as needed to keep the weeds down, some areas being treated weekly and others less frequently. Taste and odor might result from the spraying of marginal areas around a reservoir should the reservoir quickly fill after treatment, although it is possible that the oils would float and would not show up at the intake.

MOSQUITO CONTROL

Mosquitoes are responsible for the spread of certain diseases such as malaria (by Anopheles) and in addition are undesirable because of the nuisance they create. Bodies of water or streams containing quiet pools are ideally suited for the aquatic phase of the mosquito life cycle, i.e., the depositing of eggs and the development of the larvae and pupae. The impounding of water for various purposes has been an important factor in maintaining and even extending malarious zones. Control measures may be necessary on watersheds in areas adjacent to army or navy posts, defense establishments, etc.

Small streams on a watershed frequently contain more or less still water in the holes and depressions along the banks and at bends in the stream. These provide places where mosquito larvae may develop, protected from currents and sheltered by vegetation and flotage from their natural enemies. These breeding places may be eradicated or made unfavorable for mosquito breeding by stream training. In stream training, where practicable, the bends are straightened and the old channel filled. Marginal low spots subject to periodic flooding to leave shallow ponds available for mosquito breeding, should be eliminated by filling or draining. The vegetation and debris in the stream bed which might provide shelter for the larvae should be removed.

Impounding reservoirs may offer more breeding places for mosquitoes than tributary streams. Conditions which favor the harborage of mosquitoes are: (1) constant water level, (2) minimum wave action, (3) aquatic or semi-aquatic vegetation which offers protection to the larvae, and (4) absence of natural enemies of mosquito larvae, and (5) collections of flotage or debris. Effective mosquito control begins with the construction of a reservoir, at which time the banks should be cleared and cleaned from a level above high water down below the minimum water level expected during warm weather. At the same time attention should be given to those areas which would retain water as the reservoir was drawn down. Drainage should be provided to eliminate stranded ponds of water. After the reservoir is placed in service it should be stocked with top-feeding minnows. During the mosquito breeding season the water level should be varied from six to twelve inches each week, if possible. If the reservoir is being drawn down regularly during the summer months to supply the demand, it serves the same purpose as alternately raising and lowering the water surface. Fluctuation of the water surface results in the mosquito larvae being stranded to die or they are carried into open water where they may be destroyed by their natural enemies.

[6]Harris, B. B., and Silvey, J. K. G., "Underwater Cutting Tool for Aquatic Plants." J.A.W.W.A., 32: 1883. 1940.

Natural Enemies of Larvae

A number of small top-feeding fish are natural enemies of mosquito larvae. These surface minnows are prevalent in most streams in the country. In the salt marshes along all coasts of the United States will be found the salt water killy fish *(Fundulus)* or the sheepshead minnow *(Cyprinodon)* which are usually present in large numbers. The most common fish in the states east of the Rocky Mountains and south of Delaware and Illinois is the top-feeding minnow *(Gambusia affinis)*. In the northern part of the United States will be found a fresh water variety of the killy fish *(Fundulus)* or "shiners" as they are sometimes called. Some of these small fish are at times effective as mosquito control agents provided they are present in sufficient numbers and the banks of streams and reservoirs are kept free from vegetation and flotage.

Larvicides

Mosquitoes will not breed in open water where there is no cover for them, but there may be areas in a storage reservoir that require control measures. In such cases the use of some larvicides may be necessary. There are a number of larvicides that are effective in killing mosquito larvae. Highly volatile oils such as kerosene are quite toxic to all mosquito larvae, while heavier oils, such as motor lubricating oil, are less toxic and require as much as two days to be effective. Light distillate oils are efficient and most practical. Paris green, a compound containing arsenic, is very effectve in killing larvae of Anopheles mosquitoes, but does not kill the larvae of other species of mosquitoes. Boil oil and Paris green have been used successfully on water supply reservoirs without harm. The quantity of light oil required will vary from 3 to 25 gallons per acre. The quantity needed will depend on the nature of the oil used and is best determined by observing the results obtained. Sufficient oil should be used to give a noticeable film over the entire surface of the water being treated. There is little likelihood of oil getting into the intakes since they are generally well below the surface while the oil remains on the surface until it evaporates or is blown ashore. When Paris green is used it should be diluted from 1:50 to 1:100 with hydrated lime, powdered soapstone, stearates of calcium or aluminum, or other inert dust. Soapstone will cause the dust to settle from the surface quickly, while the stearates will prolong the floating period. The Paris green mixture may be blown into the air over ponds or lakes from the windward side, using a hand or motor operated dust blower similar to those used in dusting fruit trees. Airplanes have been used successfully by the Tennessee Valley Authority in Anopheles control. An application of ½ pound of Paris green or ¼ pound of copper arsenate per acre, diluted with soapstone, has been found effective.

Protection Against Sabotage

During the present national emergency the reliability of municipal water supply takes on new responsibility. Industrial and defense production in a city could be paralyzed by cutting off the water supply of that city. Surface water supplies with impounding reservoirs and long pipe lines or aqueducts may be quite vulnerable to deliberate damage. Reservoirs often

are located some distance from the municipality with the pipe lines passing through thinly populated areas where serious damage could be done without interference.

The chief danger in connection with storage reservoirs is damage to the intake structures. In most areas, dams are large enough that destructive work of such a nature as to cause failure of the dam would not be possible without detection. Intakes, on the other hand, are more easily damaged by small quantities of explosives. They are difficult to repair quickly and if damaged might interrupt normal water service for some time. A ban on fishing near intakes and a restriction on the presence of unauthorized persons in the vicinity of intakes are the chief precautionary measures that might be followed. At least one city has been reported to have installed floodlighting facilities to make it easier to guard the intake. Plans should be made outlining a procedure to be followed in case of emergency. Supplies might well be obtained and kept in readiness to construct an emergency intake if necessary.

In the intake line of a small Lake Michigan supply, a tee with a blind flange bolted to the top was installed some distance inshore of the regular intake to provide for any emergency arising out of damage to the normal intake. In this case a diver quickly could remove the cover plate to restore water service if the regular intake were damaged.

In the summer of 1940 Engineering News-Record canvassed waterworks authorities in industrial cities throughout the country relative to protection of water service from sabotage. A summary of safeguards recommended in connection with sources of supply follows:[7]

Bar visitors and fishing in the vicinity of dams and intakes.
Provide extra lights at intakes, and consider plans for the use or installation of supplemental intake facilities.
Supplement existing telephone or wire communication systems to isolated points with radio and personal messenger service.
Establish a patrol system along aqueducts and other structures, paying particular attention to vital points such as meter and valve control stations.
Prohibit parking at all times on stretches of road which pass near dams or aqueduct lines.
Restrict airplane operations in the vicinity of reservoirs and dams.
Minimize identification of access manholes and shaft entrances to tunnels and aqueducts.

Contamination of the water itself with pathogenic bacteria or with some poisons is possible, but not probable. It would require a huge amount of poison in a water supply to be serious because of the dispersion and dilution that would result in the normal impounding reservoir. Pathogenic bacteria are not likely to survive the disinfection treatment with chlorine. Precautionary measures should include frequent inspection of chlorinating equipment to see that it is operating properly at all times. Reserve chlorinating equipment, possibly a mobile solution-feed machine that can handle hypochlorites, would be valuable in an emergency. The wisdom of having such equipment available on short notice has been shown in times of flood disaster when regular chlorinating equipment could not be used.

Watershed Regulations

In some states there are no general watershed regulations set up to apply to all watersheds, each case being treated separately with its own list of rules being prepared. In this manner it may be possible to draw up only such rules as are necessary to protect the water supply from dangers that exist on the particular watershed. On the other hand, other states have formulated watershed regulations to apply to certain classes of drainage areas, these rules being applicable to any watershed falling within the given classification.

[7]Page 88, Engineering News-Record, July 18, 1940.

Unusual Operations in Surfacing, Using Tar

(Continued from page 13)

of the country. The cost is less than half that of any other bituminous mix we know of. One job with which we are familiar is in its fifth year and looks still like a new surface.

We are also mixing our own patch material with a motor grader by laying two inches of sand on a little used street, running a tar distributor over it, and mixing the tar and sand together. This gives us a stock pile, which can be used as needed. One pile will last a month or so providing the surface is allowed to crust over. Cost is about $2.00 a cubic yard to mix and stock.

This method also gives good results in trench patching. The motor grader will place the patch in the trench and grade it ready to roll. A patch mix of this type is much better if left to cure several days before using.

Applying Copper Sulphate to Reservoirs

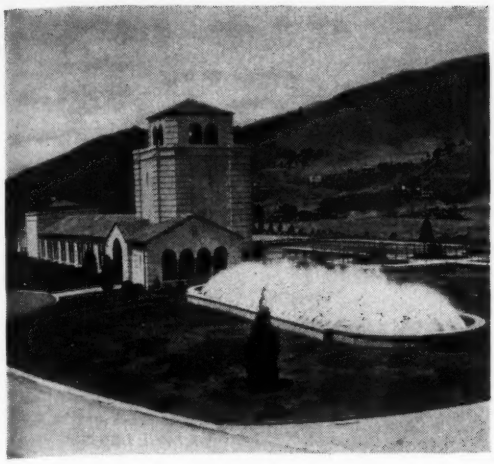
For applying copper sulphate to its reservoirs, the Division of Water of Columbus, Ohio, last year built an appliance according to plans loaned to it by the Metropolitan Water District of Southern California. It is described as follows by C. B. Hoover, superintendent, in his annual report.

The feeder consists of a turbine pump (18 g.p.m. at 90 ft. head) direct connected to a gasoline engine, a hopper holding approximately 85 lbs. of powdered copper sulphate, a rotor feeder, an ejector, and a spray nozzle device for distributing the copper sulphate solution. The distributor sprays the solution to a width of 50 ft.

It is planned to mount this equipment in the back end of a motor boat. With the boat traveling 15 miles per hour, approximately 1.5 acres can be treated in one minute. It is planned to apply approximately 7 lbs. of copper sulphate per acre of surface.

Baltimore Sells Sewage Effluent to Steel Plant

The Bethlehem Steel Co. has recently contracted with the city of Baltimore, Md., to purchase a part or all of the effluent from its Back River treatment plant for use in steel processing at its Sparrows Point plant. The company will construct a 48" pipe line to bring the effluent the 4 miles between the plants and a chemical precipitation plant for further treating the effluent, at a cost of about $2,000,000. The city contracts to produce an effluent from the activated sludge process (about 40 mgd) with a pH between 7.8 and 6.5; suspended solids not to exceed 50 ppm instantaneous maximum or 25 ppm monthly average; BOD not to exceed 45 ppm instantaneous or 25 ppm monthly; and chloride content not to exceed 170 ppm. Payment will be $1,000 a month for less than an average of 25 mgd, $1,500 a month for 25 to 37.5 mgd, and $2,000 for over 37.5 mgd.



The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Maintaining Large Meters

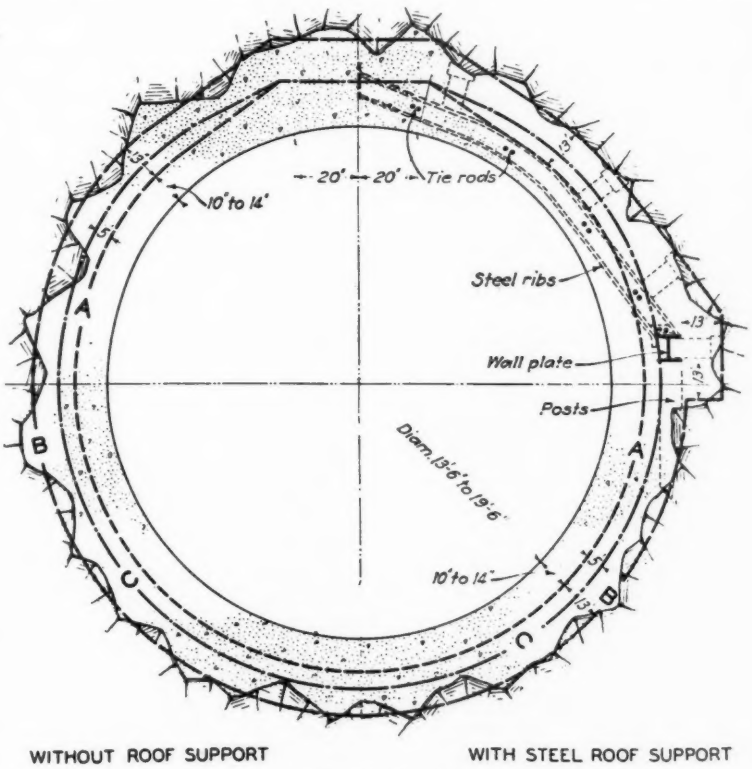
At Roanoke, Va., increase of revenue due to maintenance of large commercial and industrial meters is several times its cost. They are tested once a year, using a test meter consisting of a 3" current-type meter and ⅝" disc meter, in a silicon aluminum case to minimize weight; with a pitot rod in its inlet pipe connected to two manometers, one filled with carbon-tetrachloride and the other with mercury, for ascertaining and regulating rate of flow from 0.25 gpm to 400 gpm.[G26]

Longest Tunnel Ever Built

The Delaware aqueduct, under construction to bring water to New York City from Rondout reservoir, is a continuous pressure tunnel 85 miles long, located deep in the bed rock throughout its entire length. It is continued by 20 miles of distributing pressure tunnel in the city, making a continuous line of pressure tunnel 105 miles long—by far the longest continuous tunnel ever built for any purpose. The aqueduct is from 18 ft. to 24 ft. diameter as excavated, 13 ft. 6 in. to 19 ft. 6 in. finished diameter of concrete lining. It is being constructed from 31 shafts, under 11 contracts. Speed of driving the tunnel sets new records; the average on all 13½ ft. tunnel for a 9-week period, including delays due to bad ground, was about 200 ft. a week. The speed in building the Shandaken 11½ by 10 ft. tunnel in 1920 was 100 ft. a week. Fifty years ago, 25 to 40 ft. in good ground was the record for the Croton aqueduct. To obtain this year's record the contractors installed equipment costing from 0.5 to 0.75 million dollars per shaft. Precautions against accident and silicosis are the most complete ever employed. For the latter, a special type of drill was developed using much more water and less air for removing the drill dust. Fresh air is delivered to each heading at the rate of 10,000 to 14,000 cfm.[B18]

HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

From 150 to 300 men are employed at each shaft in three shifts, most of them coming by automobile. The water required for shower baths, lavatories, urinals and closets, and booth-washing sprays ranges from 8 to 54 gpd per man, averaging 25. At some shafts water from the nearest town was piped in; at others deep wells were sunk. All water used for drinking is chlorinated, most by sodium hypochlorite. Water is taken to the men at work in closed containers — the old open pail and tin dipper are not permitted. Chemical closets are provided in the tunnels. Buildings have water-flushed fixtures and sewage treatment plants—septic tanks, intermittent sand filters and effluent chlorinators, and open sludge drying beds.[B19]



Typical section of Delaware Aqueduct.

Cross-Connection Pollution at Rochester and Gloucester

Rochester, N. Y., has, in addition to a potable supply from Hemlock lake, a fire supply distributed through 25.65 miles of separate distribution mains in the congested area and drawn from a 2,000 gal. well which is normally kept full of Hemlock lake water, but, in case of heavy fire consumption, additional water is drawn from a 32,000 gal. well filled with river water. There were several cross-connections between these systems, all closed by valves; but on Dec. 11, 1940, a workman opened one of these, not realizing what it was, and fire pumps began pumping into the potable water system where the pressure was lower, until finally they started pumping in river water. Wonder at the continued draught on the fire system led to discovery of the cause, by which time about 5 million gallons of river water had been pumped. Immediately the valve was closed, the State Dept. of Health notified, and citizens advised by radio broadcast, newspapers and telephone to boil all water; 95,000 telephone subscribers being warned. Persons who had been guests at hotels on Dec. 11 and 12 were advised by letter to be inoculated against typhoid.

The mains were flushed and water from the two distributing

reservoirs chlorinated. However, all the chlorine equipment available in Rochester and adjacent municipalities was not adequate, and another method never before employed was adopted. A ton of HTH was procured and a solution of this pumped into the distribution system through fire hydrants, using 6 street flushers of 2,500 gal. capacity, each with two fire pumpers. Five pounds of HTH was mixed with the water in a flusher, giving 165 ppm available chlorine, and this pumped into a hydrant, another hydrant about 400 ft. away being open and then, when its flow showed a chlorine residual, it was closed and one further along the line opened. By Dec. 17 chlorine residuals of 0.4 to 1.0 ppm were found in all parts of the system and citizens notified that boiling was no longer necessary. Only five cases of typhoid were reported.

It is planned to entirely abandon the river as a source of supply and build a 3 mg storage reservoir to be kept filled with potable water for use by the fire pumps, which plan has been approved by the fire underwriters.[B23]

By a curious coincidence, only a few hours before this Rochester happening an opened valve in a cross-connection between the potable supply and a pipe carrying harbor water for cooling purposes caused pollution of the supply of Gloucester, Mass. A briny taste in the water Dec. 11 led to the discovery. All mains were at once flushed and citizens notified to boil the water. After flushing, all tap samples gave negative coliform tests. No disease was traced to this happening.[B24]

Sterilizing Mains in England

The Sutton District Water Co., which supplies a population of 325,000, mostly in the London Metropolitan area, sterilizes all new mains by use of liquid chlorine, 40 to 100 ppm being left in the main 10 to 24 hrs. Each length of pipe, before being lowered into the trench, is swabbed out with strong chlorinated soda solution and the ends closed with expanding-type stoppers, which are not removed until the joint is being made. All specials and valves are similarly treated. The yarn is sterilized and kept in air-tight tins until actually used; any left in a tin being-re-sterilized before re-issue. Service pipe, goose necks, corporation and stop cocks are immersed in a tank of dilute chlorinated soda solution for not less than 2 hrs., drained, and capped with sterilized brass caps. Tapping apparatus and tools are wiped with the same solution just before use. Meters are filled with a weak solution of potassium permanganate, and caps kept on the ends until installed. No typhoid carriers are employed by the company.[A89]

Control of Reservoir Silting

About 25,000,000 U. S. citizens obtain their water supply from reservoirs impounded by 2,600 dams. Silting will reduce the life of 20% of these to less than 50 years, and only 54% will have unsilted capacity 100 years from now to suffice for present requirements. The Soil Conservation Service of the U. S. Dept. of Agriculture has established a Sedimentation Division, which, up to May, 1941, had obtained data on silting in 450 reservoirs. Removal of silt from reservoirs seldom pays. The average cost of constructing a number of reservoirs has been about 3 cents a cubic yard; removal of silt by any known means would cost 4 to 40 times this. Three general lines of control of reservoir silting are (1) consideration of silting possibilities in the original location and design; (2) plan for removal of sediment before it has opportunity to deposit and compact; (3) protecting water shed against erosion. Silt causes loss in storage capacity and also increases cost of purification of the water. At high Point, N. C., this additional cost was estimated at $7 a million gallons. The studies indicate that the average reservoir should hold at least 75 acre-feet per sq. mi. of tributary drainage area to have a safe life of 100 yrs. Consideration should be given to the number, location and size of openings in the dam through which silt can be washed out. If the reservoir can be developed off the main channel, the silting can be greatly reduced.

Most desirable is control of soil erosion, since it benefits the water shed itself and eliminates all silting troubles. The area can be purchased and revegetated; 41 states have enacted laws permitting the organization of soil conservation districts, and more than 287,000,000 acres have been organized (450,000 sq. mi.). Control practices include crop rotations, plowing on the contour, terracing, strip cropping, vegetated drainage ways, check dams, reforestation and fire protection, and grazing control.[A79]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal American Water Works Ass'n. June*

78. Toronto's New Purification Plant and Pumping Station. By A. U. Sanderson and L. F. Allan. Pp. 1011-1021.
79. Factors in Control of Reservoir Silting. By C. B. Brown. Pp. 1022-1040.
80. Financial Considerations of Distribution System Extensions. By F. R. Berry. Pp. 1041-1052.
81. Costs of Distribution System Extensions Beyond Corporate Limits in Northern Indiana. By E. D. Anderson. Pp. 1053-1057.
82. Insurance Requirements for Water Works Properties. By R. F. Goodhue. Pp. 1058-1068.
83. What an Operator Expects from a Salesman. By L. A. Nalefski. Pp. 1069-1075.
84. What a Salesman Can Offer an Operator. By E. E. Alt. Pp. 1076-1078.
85. Utility Co-ordination in Emergencies. By L. A. Geupel. Pp. 1079-1084.
86. Recent Stream Pollution Studies in West Virginia. By K. S. Watson. Pp. 1085-1098.
87. Two Groups of Flagellated Algae Serving as Indicators of Clean Water. By J. B. Lackey. Pp. 1099-1110.
88. Nomograph for Determining Dissolved Oxygen Concentration in Water. By W. D. Hatfield. Pp. 1111-1115.
89. Pollution Prevention in Distribution Systems in Britain. By E. G. B. Gledhill and A. W. H. McCanlis. Pp. 1116-1124.

B *Journal, New England Water Works Ass'n June*

18. *c.* Construction of the Delaware Aqueduct. By R. W. Armstrong. Pp. 135-165.
19. Sanitation of Construction Areas on the Delaware Aqueduct. By F. A. Marston. Pp. 166-181.
20. Purchased Power for Water Works Pumping Stations. By W. H. Colburn. Pp. 182-194.
21. Diesel Drive for Water Works Pumping Stations. By J. W. Reynolds. Pp. 195-205.
22. Development of Stoughton's Water Collecting System. By L. Morrill. Pp. 206-215.
23. Pollution of the Rochester, N. Y., Water Supply Through Cross-Connections. By E. Devendorf. Pp. 216-229.
24. Salt Water Pollution of the Gloucester, Mass., Distribution System. By F. H. Kingsbury. Pp. 230-232.
25. Water Treatment at Groton, Conn. By A. N. Tiffany and A. L. Shaw Pp. 233-253.
26. Operation of the Cambridge, Mass., Filtration Plant. By F. E. Smith. Pp. 254-264.
27. Corrosion Control. By E. W. Moore. Pp. 265-270.
28. *t.* Hydraulic Investigation of Water Distribution Systems in Field and Office. By G. M. Fair. Pp. 271-306.

E *Engineering News-Record July 3*

9. Removing Reservoir Silt by Sluicing Operations. P. 56.

F *Water Works Engineering July 2*

67. Water Treatment at Wilmington, N. C. By N. N. Wolpert. Pp. 824-825, 849.
68. Experiences with Breakpoint Chlorination at Wheeling, W. Va. By A. R. Todd. Pp. 826-829, 849.
69. Wells as a Supply Source. Pp. 831-832.
70. Experiences at the World's Largest Filter Plant. By J. E. Kerslake. Pp. 838-840.

July 16

71. *p.* Silt Takes Heavy Storage Toll. By C. B. Brown. Pp. 874-877, 908.
72. Wells as a Source of Supply. Pp. 897, 915.

G *Water Works and Sewerage June*

25. The New Waterworks of Springfield, Mo. By L. R. Howson. Pp. 241-247.
26. The Maintenance of Large Meters in the Field. By D. R. Taylor. Pp. 249-251.
27. *p.* Reservoir Silting. By C. B. Brown. Pp. 257-263.
28. Water Waste Surveys and Leakage Correction. By E. K. Wilson. Pp. 264-267.
29. Measuring Pulsating Flow Accurately. By W. Melas. P. 289.

J *American City July*

16. Collection and Conservation of Water in Honolulu. Pp. 56-58, 79.
17. Water-Zero Hardness for Baton Rouge Consumers. Pp. 72-73.

M *Water and Sewage June*

15. Toronto's Victoria Park Water Purification Plant and Pumping Station. Pp. 30-31, 104.
16. Toronto's Island Filtration Plants. By N. J. Howard. Pp. 35, 101.
17. Chlorination in the Toronto Water Purification Plants. By R. E. Thompson. Pp. 54, 94.
18. Laboratory Services for Ontario's Waterworks. By A. E. Berry. Pp. 66, 68.
19. Laboratories of the Toronto Waterworks Dept. By N. J. Howard. P. 68.
20. A Review of Canadian Waterworks Practice. Pp. 82, 84, 99.

P *Public Works July*

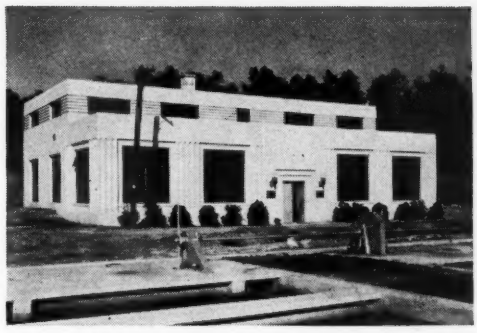
33. Experience With Lime and Calgon in Preventing Corrosion. By A. C. Southard. P. 13.
34. Attractive Water Purification Plant at Lansing, Mich. P. 22.
35. *c.* Laying a Pipe Up a 45° Slope. By B. C. Gosney. Pp. 23-24.
36. Softening St. Paul's Water Receives Public Approval. P. 28.
37. *p.* Obsolescence of Water Plant Equipment. By E. S. Hopkins. Pp. 29-30.

V *Journal, Maine Water Utilities Ass'n July*

7. Advantages of Regrinding Drill Bits. By R. L. MacDonald. Pp. 95-97.

The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.



HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Cooking Garbage For Hog Feed

Tottenham, England, produces over 400 tons a month of processed kitchen waste which it sells for hog food at £4 a ton. The garbage is cooked in two 3-ton concentrators—steam jacketed vessels in which the material is agitated with beater arms carried on a central shaft, being kept at a mean temperature of not less than 203°F for 1¾ to 2 hours, when the moisture content is reduced to about 60% and the material cooled. In May, 1941, the solid contents averaged 6% oil or fat, 15.75% albuminoids, 63.25% carbohydrates, 4.6% fibre and 10.4% mineral matters. "The material is a cheap, fairly well balanced feeding stuff and is excellent value for money in these days when feeding stuffs are so difficult." A ton of garbage produces about 2/3 ton of feed. The hog manure is valuable as a fertilizer.[D15]

Maintenance of Electrical Equipment

Fourteen superintendents of sewage plants scattered from Connecticut to S. Dakota contributed to a summary of practice in maintaining electrical equipment. In general, the following cardinal rules of electrical equipment maintenance appear to be observed by practical plant operators:

1. Make frequent inspections, and make repairs and adjustments as soon as they are found necessary.
2. Keep motors and appurtenances clean at all times.
3. Do everything possible to maintain a dry environment, free of corrosive gases, at all electrical equipment.
4. Unless electrical specialists are part of the plant personnel, do not hesitate to obtain competent advice and service when special problems arise.
5. Take no chances with respect to accident hazards. Accidents that are "impossible" sometimes occur.

In the case of motors, check bearings at fixed intervals. Remove dust, dirt, etc., from motor windings with compressed air at least once a month, avoiding use of moist air or pressure over 80 lb. Excessive dampness causes low resistance in winding insulation. Motors are dried by use of a small bowl-type electric heater at Olean. Softened insulation may be cleaned and washed with carbon tetrachloride and then painted with an insulating varnish or paint such as glyptal lacquer. Operating all motors a short time each day will keep them dry and keep the lubricant in gears and other parts.[C45]

Sewage Plant Construction in New York

In New York State during the past decade 111 sewer and sewage treatment projects costing $73,000,000 have been constructed with WPA aid. Of these 68 were new sewage treatment plants, 15 were reconstructed and enlarged plants, and 29 were sewers. Also during this period WPA aid was used on 34 new sewage treatment plants and on enlarging 27 plants and on 12 projects of sewer construction costing $2,772,000. Under the T.E.R.A. program 1,255 projects of storm and sanitary sewer and sewage treatment plants were constructed at a cost of $16,284,000. Total cost of sewers and treatment plants was over $113,000,000, of which $59,000,000 was Federal aid.[C54]

Treating Cannery Wastes

From studies at Palo Alto, Calif., it was concluded that it should be compulsory to install at canning plants screens fine enough to prevent all tomato skins from entering the sewer. Some treatment, such as chlorination of the waste before it is discharged into the sewer, may be necessary before it will be possible to remove settleable solids and some secondary treatment is needed to produce an effluent that is comparable to that produced during the balance of the year when canneries are not in operation.[C56]

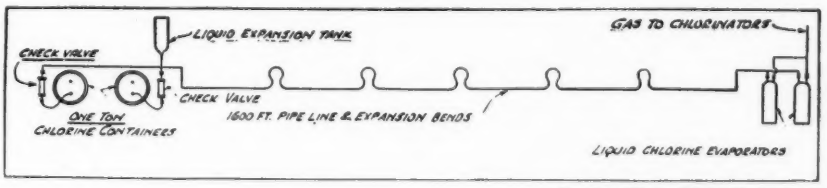
Piping Liquid Chlorine

The treatment plant of Atlantic City, N. J., is on an island connected with the mainland by a narrow foot bridge 1,500 ft. long. It uses about 3,000 lb. of liquid chlorine a day, making use of 150 lb. cylinders impracticable. Ton containers could be barged to the island; or could be housed on the mainland and unloaded by withdrawing chlorine gas and conveying it to the island through a pipe line attached to the foot bridge; or the chlorine in its liquid form could be piped from mainland to island. The last method was adopted. This necessitated a pipe line remaining tight although subjected to constant vibration of the bridge, with provision for 17" thermal expansion, protected from hydrostatic rupture due to expansion of liquid chlorine trapped in it, and provision of a device that would automatically stop escape of liquid chlorine from the ton containers in case of line breakage. The equipment in use consists of two scales, in a building on the mainland, each holding a ton container of chlorine connected to the pipe line through a line valve and ball check valve; with an expansion tank connected to the pipe line. The pipe line consists of 1,600 ft. of ¾" extra-heavy black iron pipe equipped with 5 expansion loops. On the island, solution feed chlorinators feed the chlorine to the sewage.[G22]

Dilution Water in BOD Determination

When sewage-polluted water was used as diluting water in making BOD tests of lime-precipitated waste sulfite liquor, the BOD increased from 220 ppm to 950 ppm, indicating that sewage furnished certain essential material necessary for the promotion of bacterial growth. Therefore in studying the BOD of waste sulfite liquor it is advisable to use as dilution water the water into which the waste is to be dumped, aged a sufficient length of time to satisfy most of the BOD originally present, and to use 10- or 20-day BOD in studying pollutional results of such liquor.[C49]

A committee of the Federation of Sewage Works Associations studied 1,123 samples of various polluted waters and from this concluded that the mineralized phosphate-buffered dilution water is superior to the standard sodium bicarbonate water and "recommended that a min-



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eralized phosphate-buffered water supplemented with the amount of ammonium sulfate used in this study be adopted as standard."[C50]

Rate of Yield of Vacuum Filters

The factors affecting the yield of a vacuum filter are:

1—Water present in the water-solids mixture or sludge.

2—Rate of solids deposit in the filter cake.

3—Filtration pressure.

4—Resistance of permanent medium to the flow of liquid.

5—Resistance of filter cake to the flow of liquid.

6—Time.

7—Coefficient of viscosity of the liquid.

8—Temperature of the liquid.

The construction and operation takes advantage of the above factors and introduces new factors as follows:

9—Diameter of drum.

10—Number of suction compartments in the drum surface.

11—Speed of drum (relates to 3 and 6 above).

12—Amount of drum surface submerged in sludge bath.

13—Kind and condition of filter cloth.

14—Homogeneity of sludge in filter tank.

15—Amount of vacuum during filtration and drying.

16—Blowing pressure for discharging the cake.

17—Effectiveness of filtrate drainage from revolving compartments.

18—Minimum cake thickness which can be effectively discharged.

19—Uniformity conditions conducive to continuous operation.

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n,* note or short article; *p,* paper before a society (complete or abstract); *t,* technical article.

C — *Sewage Works Journal* — *July*

48. *t.* Effective Bacteria in Purification by Trickling Filters. By C. T. Butterfield and E. Wattie. Pp. 639-658.
49. Effects of Dilution Water on B.O.D. of Waste Sulfite Liquor. By G. Martin and E. P. Miller. Pp. 659-668.
50. *t.* Dilution Water in B.O.D. Determination. Report on Cooperative Study By C. C. Ruchhoft. Pp. 669-680.
51. *t.* Inert Materials in Chemical Coagulation of Sewage. By H. W. Gehm. Pp. 681-689.
52. t. Suggested Procedure for Determination of Grease. By H. F. Ludwig. Pp. 690-693.
53. Current Developments and Trends in Sewage Treatment. By A. J. Fischer. Pp. 694-709.
54. Achievements in Sewage Treatment in ade. By E. Devendorf. Pp. 710-719. New York State During the Past Dec-
55. Problems of Industrial Wastes From the Standpoint of City Administration. By W. T. Knowlton. Pp. 720-730.
56. Developments in Cannery Waste Studies at Palo Alto. By J. H. Kimball and H. L. May. Pp. 731-741.
57. Treatment and Control of Industrial Wastes. By M. P. Adams. Pp. 742-755.
58. *t.* Natural Purification of River Muds and Pollutional Sediments. By G. M. Fair, E. W. Moore and H. A. Thomas, Jr. Pp. 756-779.
59. Stream Pollution and Control. By R. S. Weston. Pp. 780-786.
60. Experiences in Digestion Tank Scum Control. Symposium. Pp. 787-798.
61. Extracts from Reports of Toledo, Butler, Muskegon Heights. Pp. 798-806.
62. Operation of Primary Treatment Unit. By D. C. Reybold. Pp. 811-815.
63. Derivation of Gas Engine Operating Costs. By R. W. Frazier. Pp. 815-817.

G — *Water Works and Sewerage* — *June*

20. Sewage Treatment Plant of Fort Slocum. By P. Artese. P. 273.
21. Operating Fundamentals of the Activated Sludge Process. By T. R. Haseltine. Pp. 274-279.
22. Solving a Perplexing Chlorination Problem. By J. H. LeChard and G. W. Benbury. Pp. 281-284.
23. Preservation of Sewage Samples. By G. E. Phillips and W. D. Hatfield. Pp. 285-288.

H — *Sewage Works Engineering* — *July*

31. Lubricating of Engines Running on Sludge Gas. By H. S. Brown. Pp. 359-363.
32. Gas Engines Develop 35,000 Horse Power. Pp. 365-366.
33. *p.* Factors Influencing Vacuum Filtration. By A. L. Genter. Pp. 367-368.
34. 22 Gas Engines for New York City. By W. Donaldson. Pp. 375-381.
35. Wanted—Gas Storage at Birmingham, Mich. Plant. By S. J. Mogelnicki. Pp. 381-383.
36. Engines Generate 82% of Power Needs at Butler. By H. J. Kurtz. Pp. 383-384, 387.
37. Gas Engine Pays for Itself in Year at Battle Creek. By N. G. Damoose. Pp. 387-388, 391.
38. Gas Engines at Springfield's Two Plants. By J. K. Frei. P. 392.

J — *American City* — *July*

17. *p.* Sewage Gas Utilization for Heat and Power. By M. W. Tatlock. Pp. 75-76.

M — *Water and Sewage* — *June*

8. North Toronto Sewage Works. By G. Phelps. Pp. 34, 104.
9. New Sewage Treatment Plant for Toronto. P. 36.

P — *Public Works* — *July*

29. Improving Operation and Reducing Costs at the Princeton Sewage Treatment Plant. By I. R. Riker. Pp. 14-16.
30. Building a Storm Drain at Albany, Calif. By H. I. Dygert. Pp. 26, 28.
31. *n.* Extra Work on Sewer Construction Contract. P. 28.

Taxable Value of Water Reservoir

The cost to a water company of excavation, dredging, and other work required to make a parcel of land fitted for the impounding of water as a reservoir was required by the New Jersey State Board of Tax Appeals (Hackensack Water Co. v. Borough of Haworth, 17 Atl. 2d 827) to be considered in determining its taxable value, where the land was actually held and used by the water company for the storage of water. The reservoir was situated in several municipalities, including the borough, but the principal structure, a dam, was situated in only one of them. The book cost of the entire reservoir was held not evidential as to the cost of operations upon the land in the borough, in the absence of proper apportionment of the cost between structures and land, and then of the land in the several taxing districts.

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Keeping Up With New Equipment

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Austin-Western Road Machinery Co., Aurora, Ill.

The hardest and most rigid requirements of heavy construction and all-season maintenance (including accurate finishing and grading) are easily and fully met by the new, all-wheel drive and steer 99-M, according to the manufacturer.

All wheels are equipped with large diameter tires, equal in size for convenient interchangeability, and all wheels are driven and steered by power. As a result, the 99-M can grade steeper bank and ditch slopes, with a longer blade; and it can offset the frame to distribute power along the entire moldboard to move heavier loads. Other advantages are increased maneuverability and a short turning radius.

Adjustments are all made by hydraulic power control from the cab, including shifting the blade on its arms; reversing circle; steering front and rear wheels, and raising and lowering blade. When attachments are used, hydraulic power operates scarifier, loader, roller, bulldozer, snow plow and snow wing.

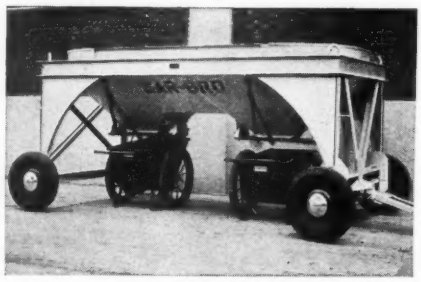
The 99-M can be furnished with either diesel or gasoline power. Full information and complete details can be obtained by writing to your nearest A-W dealers or to the manufacturer.

Low Hopper for High-Dump Truck Mixers

Garlinghouse Bros., 2416 E. 16th St., Los Angeles, Calif.

This double gate, low head room hopper for high-dump truck mixers has four wheels, a new development which not only permits easy transport, but which allows the hopper to be moved from job to job without jacking or the use of blocks. Specially low built, this hopper was designed to accommodate the mix from a four cubic yard high-dump truck mixer. A side section is easily removed to accommodate the dumping of a three cubic yard mixer!

The all-welded steel bin is built bathtub-shape to insure self-cleaning. Double clamshell gates have a floor clearance of 36 inches for loading concrete carts. Gates are 10 inches by 15 inches unless otherwise specified. Center discharge eliminates segregation. Overall dimensions, 8 feet wide by 13 feet long by 6 feet 3 inches high. Total weight, 3000 pounds.



Garlinghouse Low Height Hopper.

A New Bituminous Mixer

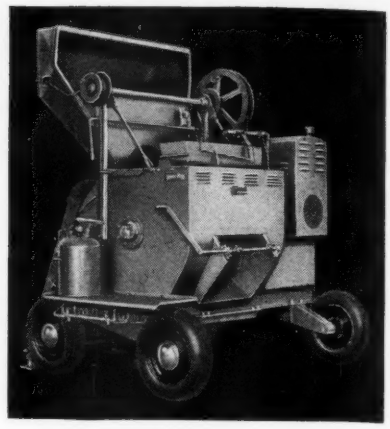
Koehring Company, Milwaukee, Wis.

A new and larger size bituminous mixer has been added to Kwik-Mix group of bituminous mixers.

It is designed for service in maintenance departments of states, counties and municipalities, as well as for contractors who pave driveways, parking lots, tennis courts and filling station approaches.

The mixer is adaptable for mixing all standard types of cold-laid mixtures of cut-backs, asphalt, tar, emulsions and

A-W "99-M" Power Grader at work on steep bank.



Koehring Bituminous Mixer.

powdered asphalts where aggregates are mixed at atmospheric temperature and the heat required for the bituminous material does not exceed 175 degrees. The two large heaters will eliminate considerable moisture from the aggregate before the bituminous material is added.

The mixer is suited for either central mixing plants, or as a portable unit to be towed from job to job on resurface, widening and general maintenance work.

Improvements in Design of Pumps

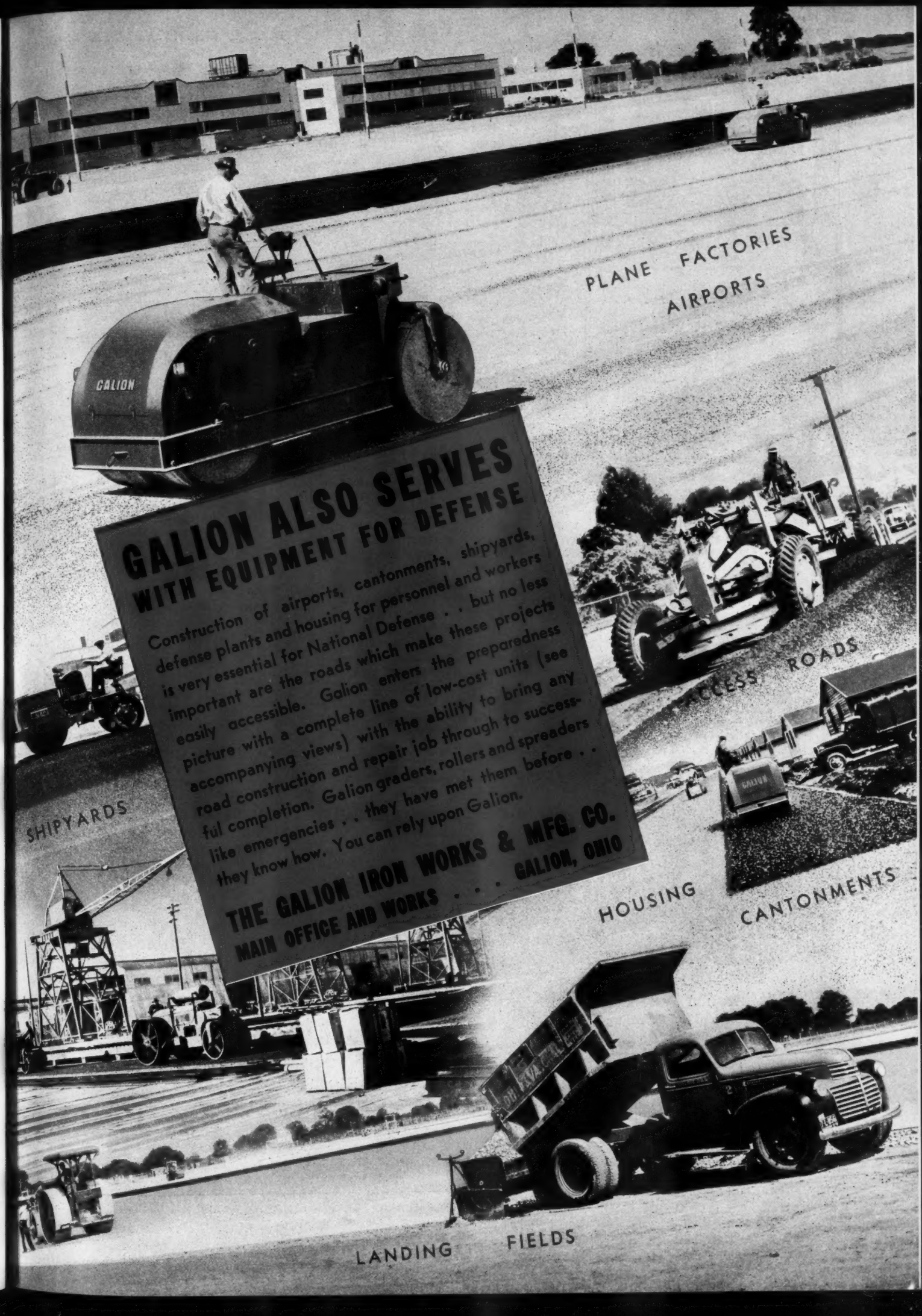
Pomona Pump Co., Pomona, Calif.

This company has recently been granted patents covering design improvements which eliminate hydraulic losses in pumps, which is claimed will increase efficiency as much as ten per cent. These improvements, now included in all sizes of Pomona Vertical Turbine Pumps, involve fundamental design changes in the guide vanes, function of which is to alter, from horizontal to vertical, the flow direction of fluids being pumped.

Previous practice in pump manufacture dictated that these guide vanes can be constructed as thin as possible on the advance edge, on the theory that the less metal the fluid would strike, the less would be the resistance encountered. However, it was discovered by Pomona engineers that, because fluid being discharged by the impeller element flows across the guide vanes at various angles (instead of always directly across the advance edge) eddy-friction losses are encountered, reducing the efficiency of the pump.

By forming these advanced vane ends of a bulbous shape, it was discovered that regardless of the flow direction of the fluid, its direction would always be substantially tangential to the vane surface. Thus, greater uniformity of flow pattern is secured, friction is reduced and efficiency of fluid lift is increased. Furthermore, because of the recessive curve at the rear of the bulb-shaped vane, eddy currents are not developed as under former circumstances.

Inasmuch as the new guide vanes are an inherent part of the pump bowl as-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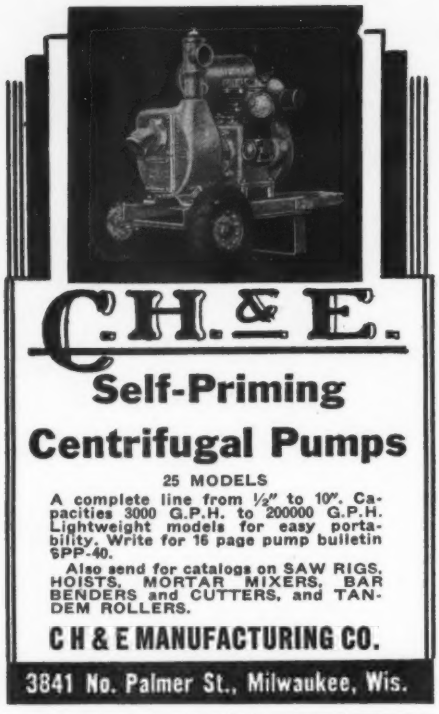
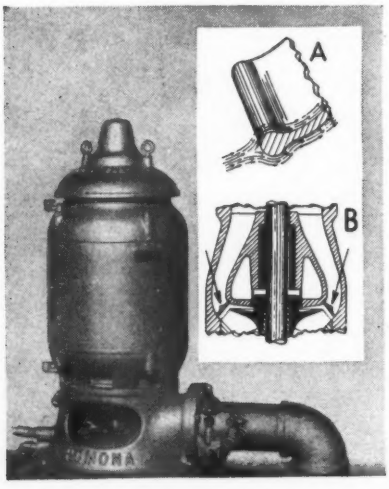

C.H.&E.
Self-Priming
Centrifugal Pumps
25 MODELS
A complete line from ½" to 10". Capacities 3000 G.P.H. to 200000 G.P.H. Lightweight models for easy portability. Write for 16 page pump bulletin SPP-40.
Also send for catalogs on SAW RIGS, HOISTS, MORTAR MIXERS, BAR BENDERS and CUTTERS, and TANDEM ROLLERS.
C H & E MANUFACTURING CO.
3841 No. Palmer St., Milwaukee, Wis.

sembly, it is not necessary for the owner of a vertical turbine pump to purchase a complete new pump in order to take advantage of the new design. It is only necessary to substitute a new bowl assembly. The manufacturer will be pleased to supply explanatory literature upon request.



Pomona Vertical Pump. A, end of guide vane; B, bowl assembly.

The Biofiltration System

An Improved Method of Trickling Filter Treatment

The Dorr Co., 570 Lexington Ave., New York, N. Y.

In Bulletin No. 7311 The Dorr Co. explains what Biofiltration comprises, what it does, where it is applicable, where it is in use, and gives its advantages in detail. It tells with photographs, flowsheets, layouts and operating costs and operating data, the complete story of the Biofiltration system now in use or under construction in 56 sewage treatment plants. This system has found a real field of usefulness in army camps, naval bases, and airports. Its ability to operate under varying conditions of load makes the system ideal for conditions prevailing at these defense centers.

Arm Type Hoist Models

Gar Wood Industries, Inc., Detroit, Mich.

There are now in production several new arm-type hydraulic hoist models which are recommended for installation on 1½- to 2-ton truck chassis and especially adapable for use in connection with dump bodies from 8 feet to 10 feet in length, according to a recent announcement by W. H. Hammond, Sales Manager of the Hoist and Body Division.

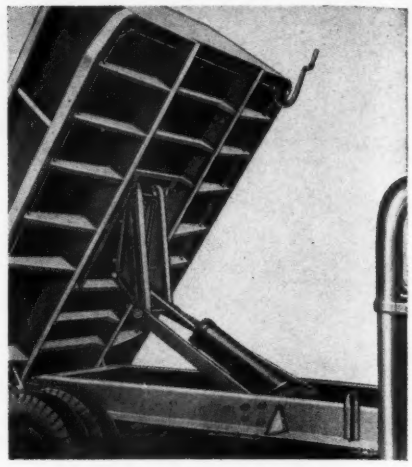
"The new arm-type hoists are being manufactured in three sizes, D6R, D7R and D7LR," Mr. Hammond stated. "These hoists incorporate desirable features and involve a new and exclusive type of lifting arrangement. The lifting effort is reduced considerably, due to the body being lifted further forward than with the conventional arm-type units. The lifting effort which is disseminated over a greater area, is confined within the self-contained assembly of the hoist unit.

"Other features such as minimum stress on body and hinges; minimum stress on truck chassis frame; longer lever arm; fewer working parts; faster operation; minimum oil pressure; low mounting (when specified) and minimum weight for an arm-type hoist, are referred to in the new Gar Wood bulletin #29, which is now being distributed to the trade and which illustrates and describes these new Gar Wood arm-type hoist models."

Improved Gasoline-driven Finishing Machine

Blaw-Knox Co., Pittsburgh, Pa.

New features are designed to provide the greater flexibility of operation. Highlighting the improvements in this new "Model XB" finisher are provisions for six traction and four screed speeds. The variety of traction speeds, coupled with the screed speeds, provides, for all practical purposes, a universal combination which will accommodate any texture of concrete or any type of paving work. On very harsh concrete, for example, it is entirely feasible to operate the traction at slow speed and the screeds at one of the higher speeds in order to get a superior finish.



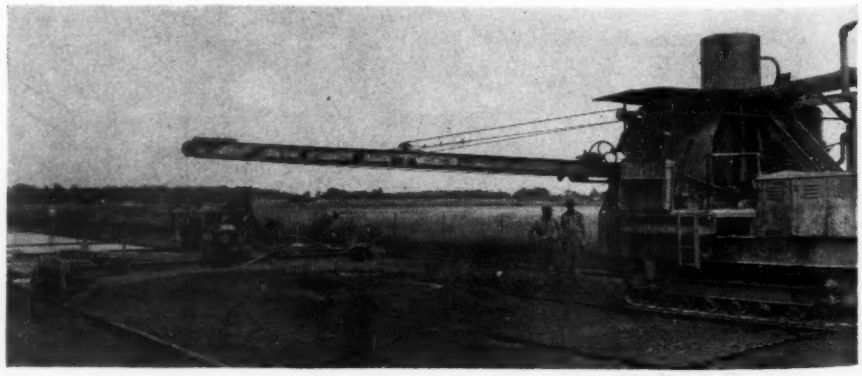
Gar Wood Arm-Type Hoist.

The new finisher is equipped with power operated hydraulic screed lifts. To raise or lower the screeds, the operator merely operates a short lever. The same type of hydraulic lift is applied to the vibrator when the finishing machine is equipped with one; this permits a much faster and easier operation for the finishing machine man.

The six traction speeds, covering both forward and reverse operation, include four working speeds and two travel speeds. For narrow machines the working speeds are 9, 12, 15, and 20 feet per minute; the travel speeds are 95 and 125 feet per minute. For wide machines the working speeds are 7½, 10, 12½ and 16½, while the travel speeds are 76½ and 102 feet per minute. Machines of exceptional width (26 to 32 feet) are designed to special order.

Combination of Affiliated Companies

Effective July 1, 1941, the combined activities of the Niagara Alkali Company and Electro Bleaching Gas Company, affiliated since 1915, will be operated under the name of Niagara Alkali Company. No change in management, facilities or personnel is effected.



Blaw-Knox "XB" Finisher provides improved operation.

PEOPLE . . . Here and There

Sewage Works Association Plans Interesting Meeting

For importance and timeliness of technical discussions, the second annual convention of the Federation of Sewage Works Associations will mark a new milestone in sewage works meetings. The convention, which will be headquartered at the Hotel Pennsylvania, New York City, October 9, 10 and 11, will bring together hundreds of engineers, operators and educators from all sections of the country, who will engage in discussions of national stream pollution questions and problems of treatment works operation. The program will fully cover all phases of sewage and industrial wastes treatment, and will place particular stress on the control and operation of various types of treatment processes.

The New York City treatment program and operating experiences will be summarized by metropolitan officials. Load distribution on the activated sludge process is scheduled for discussion as are such vital questions as the effect of industrial wastes on stream pollution conditions; utilization of sludge gas in moderate sized treatment plants; design of sewage treatment plants from the viewpoint of satisfactory operation; operation of small pumping stations; and factors influencing vacuum filtration of sludge. Preparedness and maintenance of sewerage and sewage treatment systems is scheduled for timely review.

The operator of treatment plants will have his day at the October convention as evidenced by the dominant position which operation will play on the technical program. There will be a symposium on the control and operation of sewage treatment units. An operators' breakfast will be followed by a round table discussion on such subjects as the integration of laboratory tests in the control of treatment units; handling and disposal of grit; safety procedures and chlorination problems.

Reunion Luncheons:

An innovation in sociability will be provided by a luncheon period devoted to reunion luncheons of local associations. It is expected that sufficient members of various state associations will be present and will form sectional luncheon groups for discussion of local problems.

Speakers:

Among the speakers already listed by the program committee are Professor Gordon M. Fair, Milton P. Adams, George C. Martin, Warren J. Scott, Grant M. Olewiler, A. L. Center, Professor Earle B. Phelps, C. C. Larson, G. E. Griffen, W. Donaldson and A. C. Berry.

Manufacturers' Exhibits:

An outstanding feature of the convention will be the most complete exhibit of sewerage and sewage treatment equipment and supplies.

News of Our Friends In the Army

Edward S. Hopkins, Filtration Engineer, Baltimore, Md., has been promoted to the grade of Major, Sanitary Corps. Major Hopkins, in addition to his regular duties has been advising Third Corps Area Headquarters in regard to sanitary engineering problems.

Bernard F. Hatch has been promoted to the grade of Major, Sanitary Corps. Major Hatch has been Sanitary Engineer in the office of the Surgeon, Eighth Corps Area, Fort Sam Houston, Tex. He will shortly be assigned as sanitary engineer on the staff of the Zone Constructing Quartermaster, Columbus, O.

A. S. Behrman, chemical director and vice-president, International Filter Co., Chicago, has been promoted to the grade of Lt. Colonel.

J. J. Gilbert, formerly with Link-Belt Co. and Captain, Sanitary Corps, is on active duty in Washington, D. C., as assistant to the Chief, Sub-division of Sanitary Engineering, Office of the Surgeon General, U. S. Army.

George Matsinger, formerly of Roberts Filter Co., is now on duty as Lt., Sanitary Corps, at Camp Wolters, Texas.

John E. Morgan, formerly on the staff of the City Engineer of Camden, N. J., is now on active duty as Lt., Sanitary Corps., at Fort Devens, Mass.

August Sauer, formerly airport engineer of the city of San Antonio, Tex., has been promoted to Major, Sanitary Corps, and placed on active duty at Camp Bowie, Tex.

Other engineers on duty with the Army (almost all in the Sanitary Corps) include: Lt. R. N. Clark, Headquarters, First Corps Area, Boston, Mass.; Lt. Frank Supplee, Camp Edwards, Mass.; Capt. A. J. Fuller, Headquarters, Second Corps Area, Governors Island, N. Y.; Captain R. R. Cleland, Aberdeen Proving Grounds, Md.; Capt. H. L. Baker, Capt. H. C. Jones, Capt. Lloyd Gates, Lt. Frank Elder and Lt. W. R. Cattell at Carlisle Barracks, Pa.; Lt. Col. J. J. Hinman, Jr., and Lt. Walter Culley, at Fort Belvoir, Va.

Foster D. Snell, Inc. Increases Staff

Recent additions to the staff of Foster D. Snell, Inc., 305 Washington St., Brooklyn, N. Y., include: John A. Casey, B.A., Brooklyn College; R. Neil Dalton, B.S., Brooklyn Polytechnic Institute; John Mandel, graduate of the University of Brussels (Belgium); William A. Rassiga, B.S., College of the City of New York; M.A., Columbia University.

Association Meetings

New England Sewage Works Association will hold its 12th Annual meeting at Providence-Biltmore Hotel, Providence, R. I., Sept. 19-20.

Engineering Society of Western Pennsylvania will hold its Second Annual Water Conference at William Penn Hotel, Pittsburgh, Pa., November 3-4.

Pennsylvania Sewage Works Association's 15th Annual Conference will be held at State College, Sept. 3-5.

Pittsburgh-National Meter Men Hold Breakfast

With 36 representatives present, the Pittsburgh Equitable Meter Company had a large turnout at the recent A.W.W.A. Convention. Col. W. F. Rockwell, president of the firm, presided at a series of breakfast conferences for the group which included salesmen from both the Pittsburgh and National divisions as well as factory executive personnel. The recently announced EMPIRE Streeemline meter was thoroughly discussed at their meetings and general matters of sales policy were covered.

FRONT ROW—seated, left to right: P. R. Carlon, A. L. Firtchey, W. A. Wood, A. J. Kerr, C. R. Zeskey, C. F. Thomas, Col. W. F. Rockwell, Capt. A. E. Higgins, G. E. Gleeson, N. J. Kenny, M. J. Harper, A. R. Whittaker, W. F. Parker.

SECOND ROW—standing, left to right: H. L. McLaughlin, Daniel Gannon, W. L. Herron, T. R. Finley, F. W. Hartman, F. R. McDonald, Z. A. Stanfield, F. A. Lucas, A. B. Crossman, C. C. Moore, W. C. Noyes, E. C. Hidlay, D. D. Foster, John McKague, E. P. Lufkin.

THIRD ROW—standing, left to right: F. C. Taylor, R. S. Reed, Jr., George Bender, N. Stuart Mills, Fred Simpson, Ross Burns, L. A. Dixon, R. H. Smith, J. W. Fleet, V. H. McClure, J. N. Kint.

Readers' Service Department

These booklets are FREE. Use the coupon below or write the manufacturer direct, mentioning PUBLIC WORKS.

Construction Materials and Equipment

Cold Mix Plants

10. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

72. "3 Answers to Limited Headroom," a comparison of three ways of providing safe strength and adequate drainage under limited headroom. For copy ask Armco Drainage Products Assn., Middletown, Ohio.

Mud-Jack Method

107. How the Mud Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities — a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from ½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

Retaining Walls

126. Charts showing the design of cellular or bin-type metal retaining walls, helpful suggestions on their use for stabilizing slopes, preventing stream encroachment, and solving problems of limited right of way, and construction details are given in a 16-page bulletin entitled, "ARMCO Bin-Type Retaining Walls." It is published by the Armco Drainage Products Association, Middletown, Ohio, and member companies. Ask for Bulletin H-37.

Road Building and Maintenance

129. New bulletins illustrate and describe the latest line of Littleford Utility Spray Tanks, Street Marking Units, Street Flushers and Kettles. Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

Spreader

147. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.—4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Street and Paving Maintenance

Asphalt Heaters

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hotstuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland, Mich.

211. A complete booklet on dust control titled, "Dust Control and Road Stabilization," describes the use of Columbia Calcium Chloride for dust control purposes and stabilization of roads. Sent on request by Columbia Alkali Div., Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, New York, N. Y.

212. "Are You Annoyed by Dust?" an illustrated circular telling how to prevent dust with calcium chloride. Sent free by Michigan Alkali Co., 60 East 42 St., New York, N. Y.

Radio Communication, Two Way

250. Valuable information on how cities and towns all over the country have solved their radio communication problems is found in "Motorola Radio Communication Equipment." Write Galvin Mfg. Corp., 4545 West Augusta St., Chicago, Ill.

Snow Fighting

Plows

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Ice Control

351. "Make Icy Highways Safe for Traffic"—a new bulletin by Michigan Alkali Co., 60 East 42 St., New York, N. Y., tells how to use calcium chloride for modern ice control.

Sanitary Engineering

Activated Alum

354. "Technical Data on Activated Alum and Dustless Blackalum" points out the analytical side of Activated Alum and Blackalum. Write Activated Alum Corp., Curtis Bay, Baltimore, Md.

Aero-Filter

356. New illustrated bulletin gives complete information on design of Aero-Filters to provide high-capacity, uniform, raindrop application over the entire filter bed. Write Lakeside Engineering Corp., 222 West Adams St., Chicago, Ill.

Air Release Valves

357. Automatic Air Release Valves for water, sewage and industrial uses are described and illustrated in new catalog issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

376. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Cleaning Sewers

383. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. % 96 Codding St., Providence, R. I.

Filter Bed Agitator

388. 60-page booklet, "The Mechanics of Filter Bed Agitation," containing engineering data, technical information concerning surface wash and opinions of users will be sent promptly by Activated Alum Corp., Curtis Bay, Baltimore, Md.

Filter Plant Controllers

389. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Fire Hydrants

390. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Anniston, Ala.

391. See listing No. 410.

Flow Meters

393. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others — and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

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Gates, Valves, Hydrants

394. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

396. See listing No. 410.

Gauges

398. The full line of Simplex gauges for filtration plants are illustrated and described in catalog issued by Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Hypochlorinators

400. New illustrated booklet W&T 357 describes this simple, inexpensive means of protecting small water supplies such as summer camps, hotels, swimming pools, dairies, etc., as well as for feeding chemical solutions in the water works plant. Contains typical installation sketches. Write "Wallace & Tiernan Co., Inc., Newark, N. J.

Manhole Covers and Inlets

402. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., Lafayette Boul. and Indiana Ave., South Bend, Ind.

Manhole Cover Silencers

403. New bulletin on Tapax for quickly ending noisy manhole covers and small sample free. Write Tapax Mfg. Co., 201 Hoyt Ave., Mamaroneck, N. Y.

Meters, Venturi

405. MS Meters for use with venturi tubes, flow nozzles, etc., in wall, panel, or floor mounting are covered in detail in catalog sent free by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

406. New bulletin illustrates Builders Air Relay system of transmission for the Venturi Meter which is particularly useful for liquids containing suspended solids like sewage. Eliminates corroson, clogged pipes, etc. Write Builders Iron Foundry, Codding St., Providence, R. I.

Meters, Water

407. Complimentary bulletin W529 tells all about Pittsburgh IMO water meters, "the meters that wear in where others wear out." Write Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe, Reinforced Concrete

412. Literature describing the manufacture and installaton of Lock Joint Reinforced Concrete Pressure Pipe for water supply lines and sewer force mains. Lock Joint Pipe Co., Ampere, N. J.

Pipe, 2-inch Cast Iron

417. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis, Tenn.

Meter Setting and Testing

430. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 48-page booklet you should have a copy of. Ask Ford Meter Box Co., Wabash, Ind.

Sand Expansion Indicator

432. New bulletin gives full details of Simplex Sand Expansion Indicators for water plants. Write Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

434. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

Steel Sheet Piling

436. "Metal Sheeting for Lower Average Job Costs" is a new bulletin about light weight sheeting you can use again and again. Issued by Armco Drainage Products Assn., Middletown, Ohio.

Sewers

437. "ARMCO Sewers" is the title of a 48-page booklet describing the structural and other advantages of ARMCO Ingot Iron. Paved Invert and Asbestos-Bonded pipe for storm and sanitary sewers. Design data and large charts will be found helpful by engineers engaged in the design or construction of sewers. Copies will be sent on request by the Armco Drainage Products Association, Middletown, Ohio, or its associated member companies.

Septic Tanks, Small

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip Inc., 504 E. Glen St., Syracuse, N. Y.

Sludge Drying and Incineration

440. "Disposal of Municipal Refuse." Complete specifications and description including suggested form of proposal; form of guarantees; statements and approval sheet for comparing bids with diagramatic outline of various plant designs. 48 pages. Address: Morse Boulger Destructor Co., 216-P East 45th St., New York, N. Y.

441. Full information about Nichols modern, efficient gabage and refuse incinerators now available in the Basket Grate, Continuous Grate, Revolving Grate and Monohearth types will be sent promptly by Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

442. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Plainfield National Bank Bldg., Plainfield, N. J.

443. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes — a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Swimming Pools

446. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

447. 40-page Manual on swimming pools. Includes swimming and pool layouts, specifications, etc., and details concerning Permutit Swimming Pool Equipment. Write The Permutit Co., Dept. G-4, 330 West 42 St., New York, N. Y.

Treatment

453. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

455. New booklet (No. 1642 on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

456. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewarage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia, Pa.

457. New illustrated folder (1942) on Straightline apparatus for the removal and washing of grit and detritus from rectangular grit chambers. Address: Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

458. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, 570 Lexington Ave., New York, N. Y.

459. A combination mechanical clarifier and mechanical digester, The Dorr Clarigester, is explained and illustrated in a bulletin issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

460. This new 145 page illustrated chemical products book contains 55 pages of Tables, Factors and valuable Reference Data. Issued by General Chemical Co., 40 Rector St., New York, N. Y.

461. Preflocculation without chemicals with the Dorrco Clariflocculator in a single structure is the subject of a new booklet issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

462. Dorrco Monorake for existing rectangular sedimentation tanks, open or closed, is described and illustrated in a new catalog sent on request. The Dorr Co., 570 Lexington Ave., New York, N. Y.

Tunnel Liners

480. "Save Money with Armco *Light Duty* Tunnel Liner" is a bulletin you'll want if you are interested in economical, long lasting tunnels. Write Armco Drainage Products Assn., Middletown, Ohio.

Valves (See Gates, Air Release, etc.)

Water Works Operating Practices

490. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Activated Alum Corp., Curtis Bay, Baltimore, Md.

491. "Soft Water for Your Community" tells by means of many interesting pictures and text the advantages of soft water to any community. Ask for a copy from The Permutit Co., Dept. G4, 330 West 42nd St., New York, N. Y.

492. "Alkalies and Chlorine in the Treatment of Municipal and Industrial Water" is a new comprehensive survey filled with tables, charts, cost comparisons, etc., valuable to all who treat large volumes of water. Write Solvay Sales Corp., 40 Rector Street, New York City.

Water Service Devices

500. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., will be sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio.

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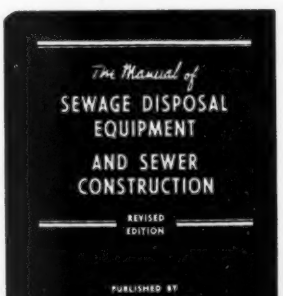

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For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

RESULTS OF MUNICIPAL ELECTRIC SYSTEMS, 1941. By Burns & McDonnell, Kansas City, Mo. 428 pages, graphs, tables. $5.00.

Under the above title this firm has just published their seventh edition of an electric rate book showing the operating records of earnings, output, rates, revenues, valuation, and other information as to the use and cost of electricity in 758 municipally-owned systems.

The volume is accompanied by interesting graphs and tables showing the rates and revenues, also facts pertaining to the increasing use and the decreasing cost of electricity in municipal installations.

New Appointments:

The following City Engineers were recently appointed:

E. G. Blakewood, Jr., Baton Rouge, La.
J. E. Dishington, Crookston, Minn.
Leon Groves, Sikeston, Mo.
John A. Bruce, Ogallala, Nebr.
A. L. Cornell, Denison, Tex.

New Water Works Superintendents include:

S. E. Hoehimer, Lake Worth, Fla.
Mike Schmidt, Junction City, Kan.
Arthur Johansen, South Sioux City, Nebr.
W. B. Schlosser, Eaton, Ohio.
L. H. Payne, Punxsutawney, Pa.

County Engineers recently reported are:

Earl Berry, Marion Co., Yellville, Ark.
Glenn McCurdy, Lucas Co., Chariton, Ia.
J. J. Wardrip, Neosho, Co., Erie, Kan.
Carman Payne, Johnson Co., Olathe, Kan.
Roy Jablonsky, St. Louis Co., Clayton, Mo.
Thomas Judge, Lewis Co., Helena, Mont.
Arthur J. Yaw, Erie Co., Buffalo, N. Y.
H. O. Walberg, Skagit Co., Mt. Vernon, Wash.

Henry G. Shirley, Dead

After a long illness Mr. Shirley passed away at his home in Richmond, Va., on July 16.

Mr. Shirley, who was formerly head of the Maryland Road Commission, was executive secretary of the Federal Highway Council in 1918. He was a member of the American Society of Civil Engineers; a member and first president of the American Road Builders Association, and at his death was serving as a member of the executive committee of the American Association of State Highway Officials.

K. D. Jaquith Passes On

Kenneth D. Jaquith, president of San-Equip, Inc., Syracuse, N. Y., died June 30, aged about 41.

Index to ADVERTISEMENTS

Alvord, Burdick & Howson..... 43
Armco Drainage Products Assn..... 5

Black and Veatch 43
Briggs & Stratton Corp..... 51
Browne, Floyd G..... 43
Buck, Seifert & Jost..... 43
Buffalo Springfield Roller Co..... 35
Builders-Providence, Inc..... 42

Cafe Monaco 31
Caird, James M..... 43
C. H. & E. Mfg. Co..... 46

DeWitt Hotels 23
Dorr Co., The..... 4
Dow, A. W., Inc..... 43

Fitch Recuperator Co..... 30
Ford Meter Box Co..... 50
Frink Mfr., Carl H..... 35
Furby's Automatic Liquid Proportioner Co., Dr. Robt. L..... 31

Galion Iron Works Mfg. Co..... 45
Gannett, Eastman & Fleming, Inc.... 43
Gorman-Rupp Co. 23
Greeley & Hansen..... 43
Green Co., Howard R..... 43

Harrub Engineering Co., C. N..... 43

Industrial Chemical Sales Div..... 6

Jaeger Machine Co..... 19

Koehring Co. 19

Lakeside Engineering Corp..... 30
Layne & Bowler, Inc..... 8
Link-Belt Co. 3
Littleford Brothers 33
Lock Joint Pipe Co..... 31
Lord Baltimore Hotel..... 24

Master Builders Co., The..... 2
McWane Cast Iron Pipe Co..... 21
Metcalf & Eddy..... 43
M&H Valve & Fittings Co..... 24
Michigan Alkali Co..... 25
Mohawk Asphalt Heater Co..... 25
Morse Boulger Destructor Co..... 31
Murdock Mfg. & Supply Co..... 50

Pacific Flush Tank Co..... 32
Pirnie, Malcolm 43
Proportioneers, Inc. ..... Back Cover

Quinn Wire & Iron Works..... 25

Robert & Co., Inc..... 43
Roberts Filter Mfg. Co. 32
Russell & Axon Cons. Engrs., Inc..... 43

San-Equip., Inc. 27
Simplex Valve & Meter Co..... 51
Snell, Inc., Foster D..... 43
South Bend Foundry Co..... 32
Stuart-Brumley Corp.....Front Cover

Tapax Mfg. Co..... 35